Dräger medical
A Dräger and Siemens Company

Technical Service Manual

Fabius GS
Inhalation Anesthesia Machine

Revision 1.0
5330.500
9036095

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General

1 Advisory

Dräger Medical is liable for the safety of its equipment only if maintenance, repair, and modifications are performed by authorized personnel, and if components affecting the equipment's safety are replaced with Dräger Medical spare parts.

Any modification or repair not done by Dräger Medical personnel must be documented. Such documentation must:

- be signed and dated
- contain the name of the company performing the work
- describe the changes made
- describe any equipment performance changes.

It is the responsibility of the user to contact Dräger Medical to determine warranty status and/or liabilities if other than an authorized Dräger Medical technician repairs or makes modifications to medical devices.

2 Important information

This Technical Documentation/Service Manual conforms to the International Standard IEC 60601-1.

Read each step in every procedure thoroughly before beginning any test. Always use the proper tools and specified test equipment. If you deviate from the instructions and/or recommendations in this Technical Documentation/Service Manual, the equipment may operate improperly or unsafely, or the equipment could be damaged.

The maintenance procedures described in this Technical Documentation/Service Manual may be performed by qualified service personnel only. These maintenance procedures do not replace inspections and servicing by Dräger Medical.

Strictly follow the Instructions for Use/Operating Instructions! This Technical Documentation does not replace the Instructions for Use/Operating Instructions. Any use of the product requires full understanding and strict observation of the product-specific Instructions for Use/Operating Instructions.

Unless otherwise stated, reference is made to laws, regulations or standards (as amended) applicable in the Federal Republic of Germany.

2.1 Symbols and Definitions

This symbol is used to provide important information that, if ignored, could lead directly to a patient's or operator's injury. It is also used to provide important information that, if ignored, could lead directly to equipment damage and, indirectly, to a patient's injury.

The following three alert levels are used in this documentation to indicate a hazardous situation and how to avoid it.

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Danger
Danger indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

Warning
Warning indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

Caution
Caution indicates a hazardous situation which, if not avoided, may result in minor or moderate injury. Caution may also be used to alert against unsafe practices.

Note
This symbol is used to provide additional information, operating tips, or maintenance suggestions.

This pictograph is used to alert against unsafe practices when handling electrostatic sensitive devices (ESD). It prompts the reader to observe standard precautions for protecting the equipment from static electricity.

Definitions according to German standard DIN 31051:

Inspection	=	examination of actual condition
Servicing	=	measures to maintain specified condition
Repair	=	measures to restore specified condition
Maintenance	=	inspection, servicing, and repair

3 Recommendations

Because of the sophisticated nature of Draeger Medical, Inc. anesthesia equipment and its critical importance in the operating room setting, it is highly recommended that only appropriately trained and experienced professionals be permitted to service and maintain this equipment. Please contact DrägerService® at (800) 543-5047 for service of this equipment in North America. For service in Europe call 49 (451) 882-4222. For service in other countries call (215) 721-5402.

Draeger Medical, Inc. recommends that the Fabius GS be serviced at six month intervals. Periodic Manufacturer's Certification agreements are available for equipment manufactured by Draeger Medical, Inc. Please contact us for further information concerning these agreements.

Draeger Medical, Inc. products /material in need of factory repair shall be sent to:

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For North America and other countries except Europe:	For service in Europe:
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4 How to use this manual

The manual is divided into several sections. The DIAGNOSTICS section describes self-test and service diagnostics for checking the system functions. An understanding of the on-board service capabilities is necessary before any attempt is made to troubleshoot the unit. The TROUBLESHOOTING section lists error codes and provides troubleshooting guides to assist the Technical Service Representative in locating the source of a problem. The REPLACEMENT PROCEDURES section contains instructions for removal and replacement of assemblies that are considered field-replaceable. The ADJUSTMENT AND CALIBRATION PROCEDURES section contains the field procedures needed to restore original system specifications. The Periodic Manufacturer's Service (PMS) PROCEDURE section outlines the steps required to verify the electrical, mechanical and pneumatic safety of the unit and also identifies components requiring periodic replacement. The SPARE PARTS section is provided for use as a reference only to obtain part numbers and descriptions for parts and assemblies for replacement purposes. For items not shown in the spare parts section, contact DrägerService®.

5 General troubleshooting guidelines

Troubleshooting the Fabius GS should always begin by communicating with those who observed or experienced a problem with the unit. This may eliminate unnecessary troubleshooting steps. Once a general problem is identified, refer to the troubleshooting flow charts to determine the proper corrective action to be taken.

After any component is replaced, verify that the unit is operating properly by running the appropriate diagnostic procedure. The PMS PROCEDURE must also be performed after any component is replaced.

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Function Description

1 General Information about the Fabius GS

The Fabius GS comprises the following assemblies:

- Bezel assembly: Display and Control Panel
- Flowmeter assembly
- Gas Box: Gas Inlet Assembly and related items
- Breathing system
- Pneumatic Assembly
- Ventilator
- Anesthetic vaporizer(s)
- Trolley

Monitoring, Electrical and Gas connections are illustrated in Figure 1, Figure 2, Figure 3 and Figure 4.

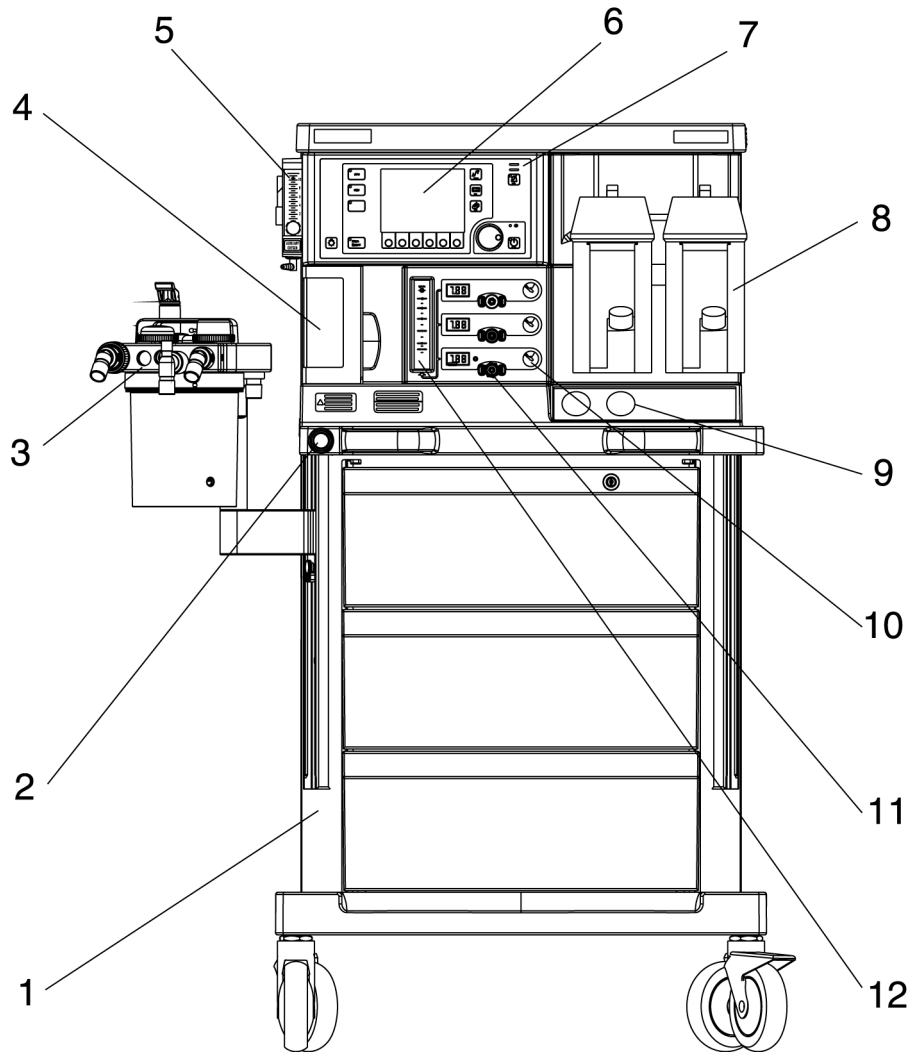

Figure 1 Front View of Fabius GS Anesthesia System, for legend see Table 1

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Table 1 Legend to Figure 1

No.	Name
1	Trolley
2	O2 Flush
3	Breathing System
4	Ventilator
5	Auxiliary Oxygen Flowmeter
6	Display
7	Control Panel
8	Vaporizer
9	Cylinder Pressure Gauges
10	Pipeline Pressure Gauges
11	Flow Controls
12	Total Fresh Gas Flowmeter

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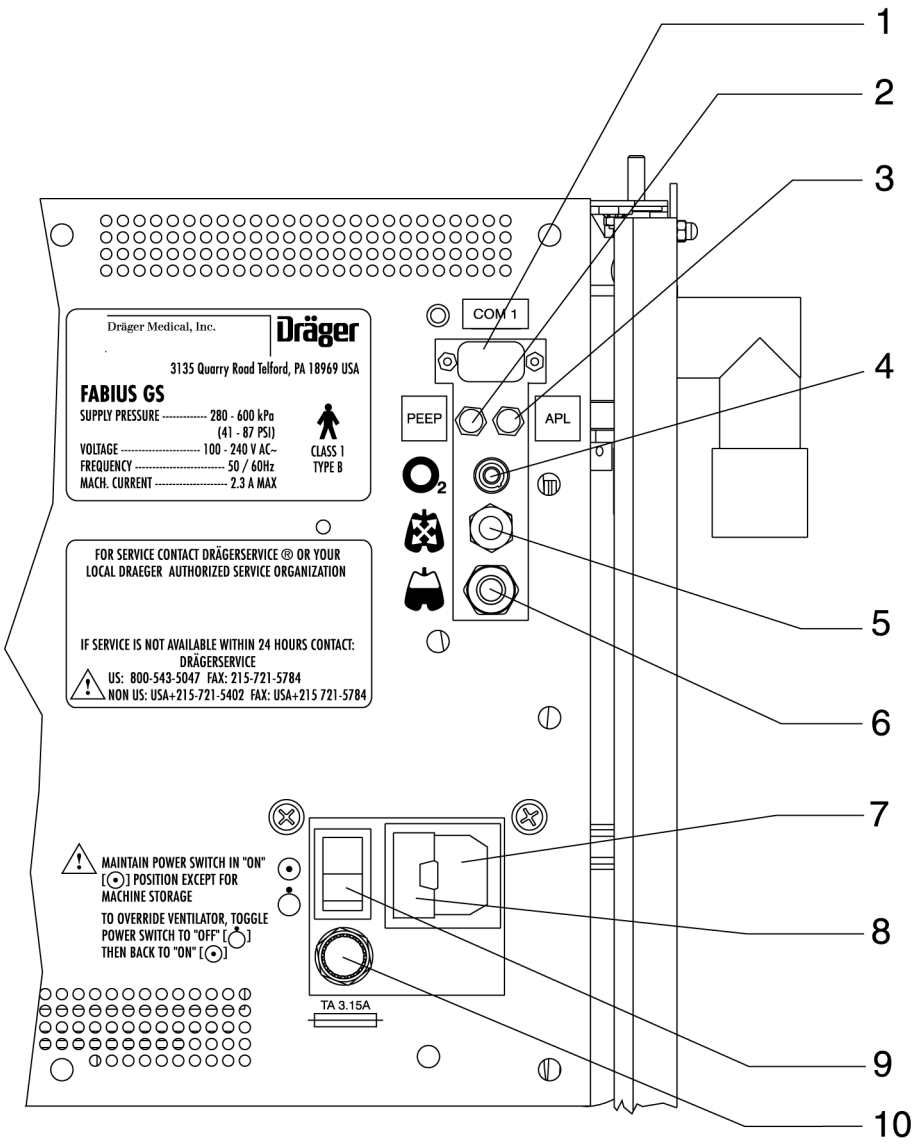

Figure 2 Back View Showing Interface Panel and Power Entry, for legend see Table 2

Table 2 Legend to Figure 2

No.	Name
1	Serial Communication Port
2	Hose Connection for PEEP Valve
3	Hose Connection for APL Bypass Valve
4	O2 Sensor Connection
5	Breathing Pressure Pilot Line Connection
6	Flow (Volume) Sensor Connection
7	AC Power Connection
8	Access Panel for Mains Fuses (2x 2.5 A)

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No.	Name
9	On-Off Switch
10	Battery Fuse

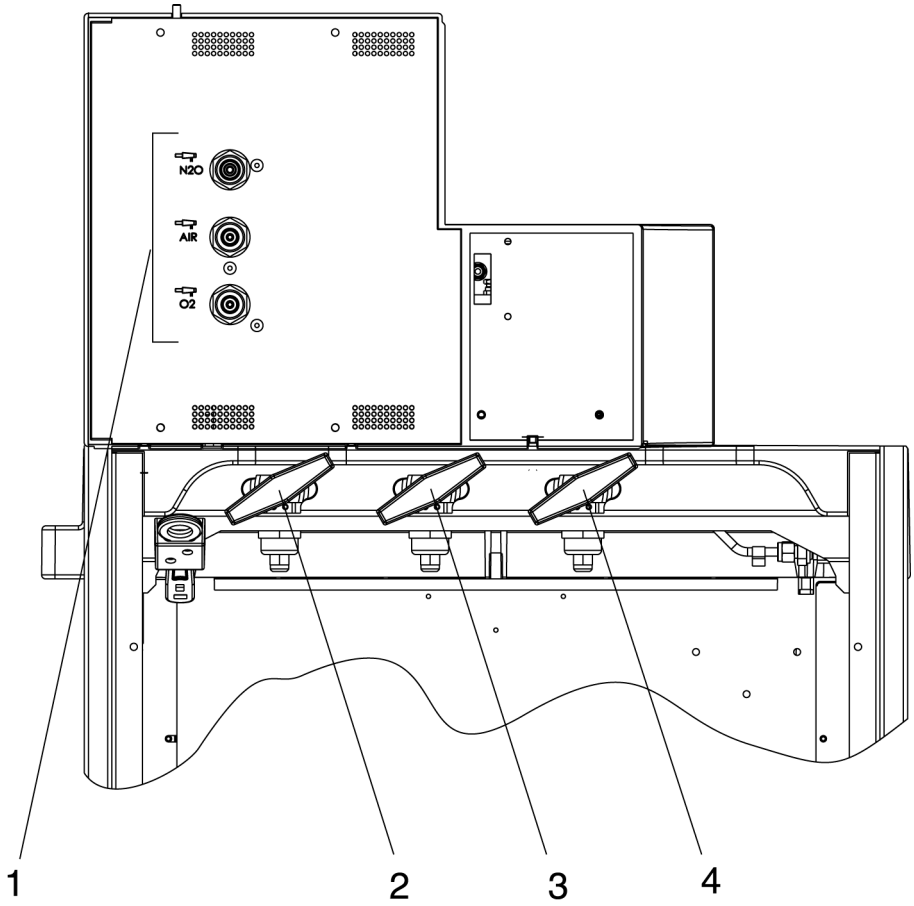

Figure 3 Back View Showing Gas Pipeline and Cylinder Yokes, for legend see Table 3

Table 3 Legend to Figure 3

No.	Name
1	Pipeline Hose Connections
2	N2O or AIR Cylinder Yoke
3	O2 Cylinder Yoke
4	O2 Cylinder Yoke

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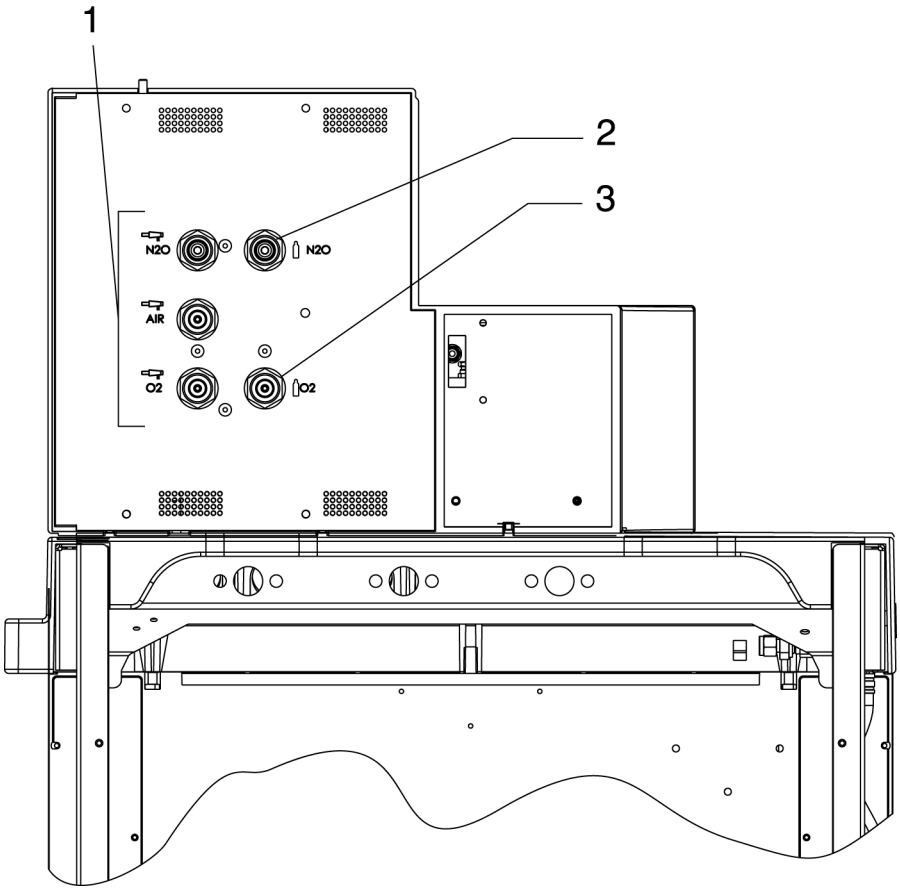

Figure 4 Back View Showing Gas Pipeline and Cylinder Hose Connections (machines without cylinder yokes), for legend see Table 4

Table 4 Legend to Figure 4

No.	Name
1	Pipeline Hose Connections
2	N2O Cylinder Connection
3	O2 Cylinder Connection

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2 Fabius GS Function Diagram

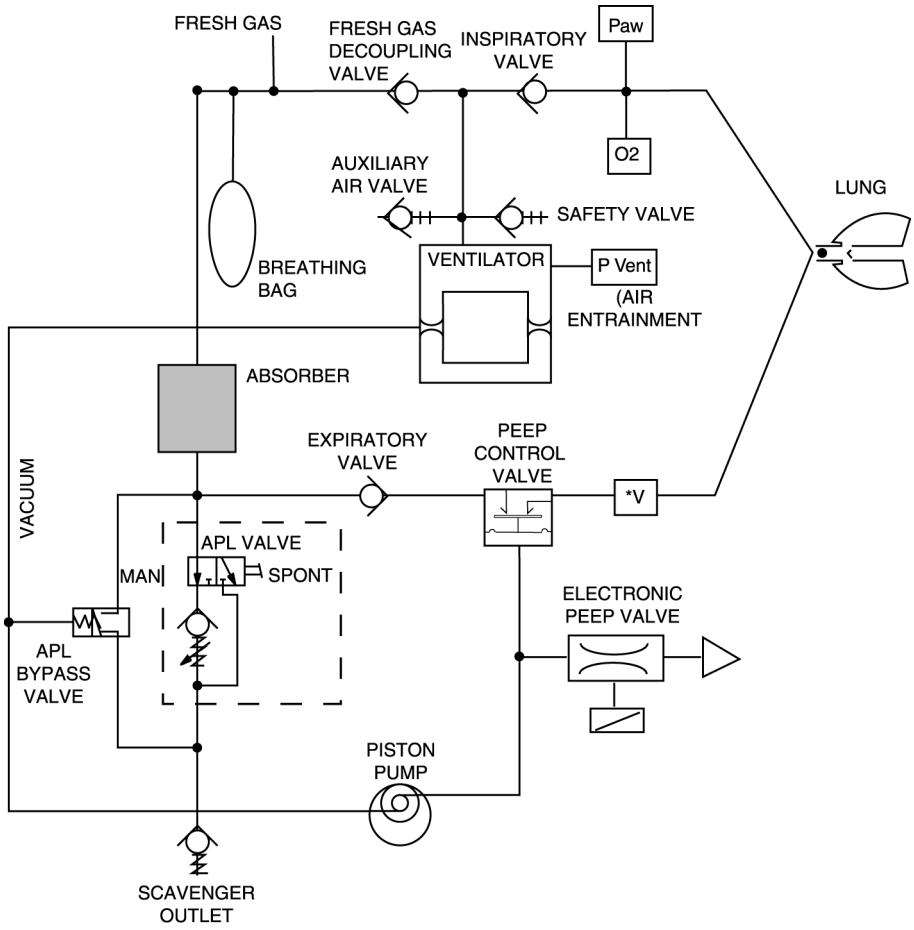

Figure 5 Function diagram of Fabius GS - Typical for Breathing System P/N 4116398 or 4117529

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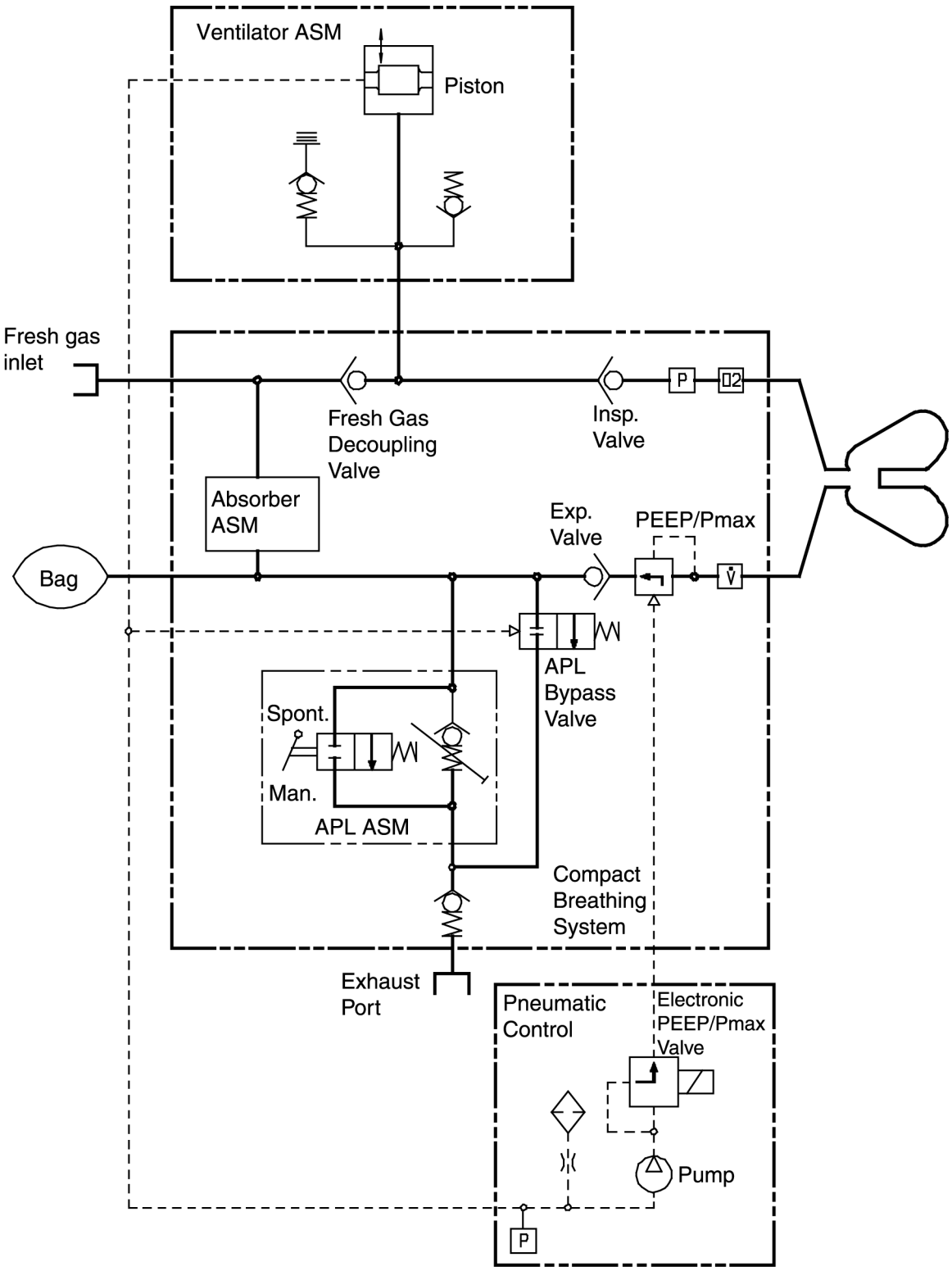

Figure 6 Function diagram of Fabius GS - Typical for Breathing System P/N 4118378 or 4118379

3 Battery Backup

Fabius GS backup power is provided by two series-connected 12 V rechargeable batteries. These batteries remain on charge as long as the machine is plugged into an active AC outlet. Should power to the main controller PCB

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assembly fail while the machine is in operation, the batteries will allow the machine to continue operating for a minimum of 45 minutes, provided the batteries are fully charged.

The batteries are located within the controller housing and are accessible by opening the ventilator compartment. The 3.15A battery fuse is located on the power entry panel at the back of the machine.

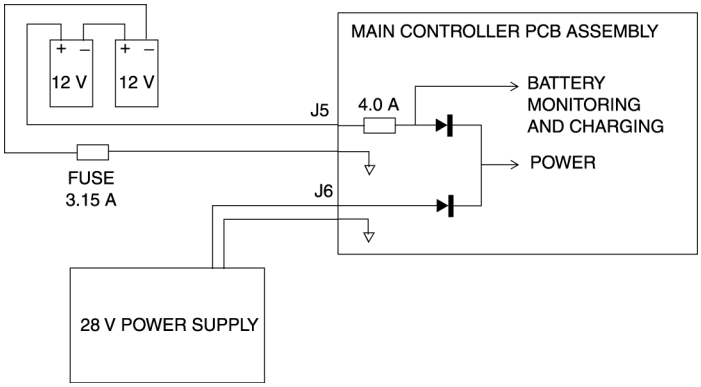

Figure 7 Battery Backup Arrangement

4 Fabius GS Piping Diagram

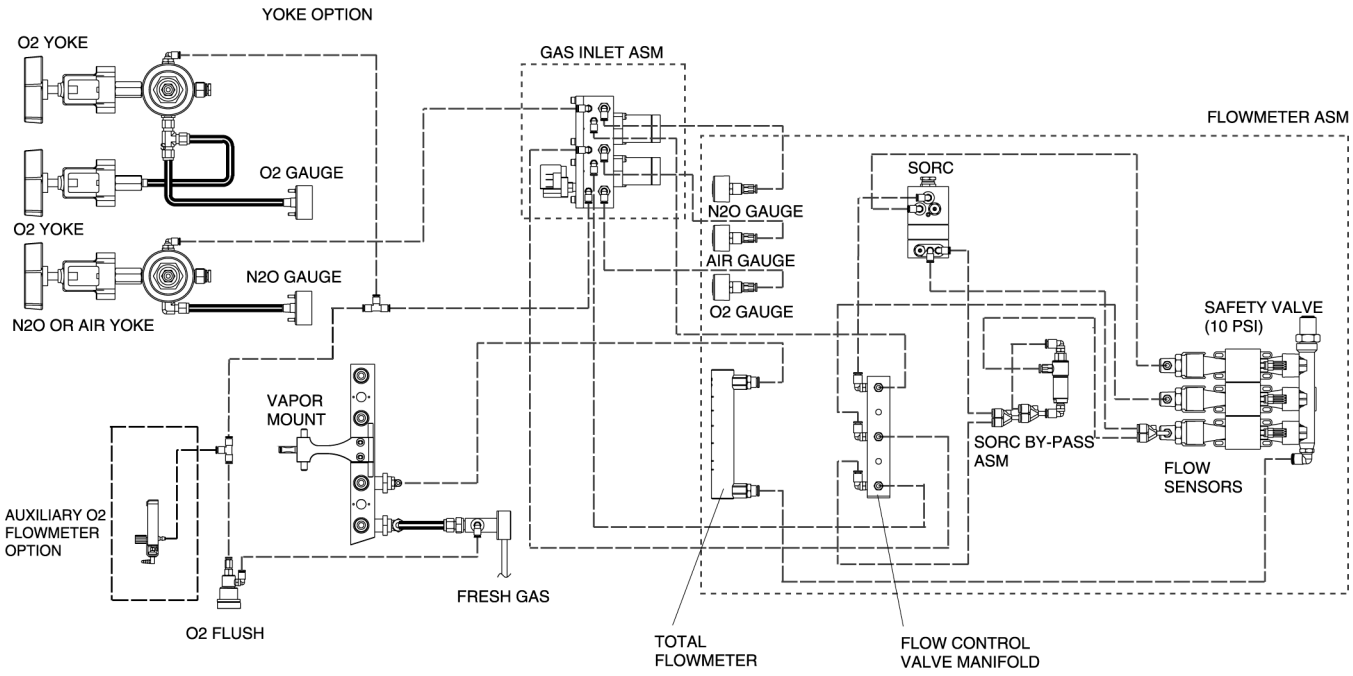

Figure 8 Fabius GS Piping Diagram

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5 Function Description of Gas Box

The supply gases flow through the filters and non-return valves in the gas inlet assembly. Pipeline supply pressures are indicated on gauges located on the flowmeter assembly. Cylinder pressure gauges are located on the trolley assembly. The pressures of O2 and N2O delivered to the flowmeter assembly are set by regulators on the gas inlet assembly.

Should the O2 supply fail or its pressure decrease below a certain limit, the O2 supply pressure alarm switch signals an alarm.

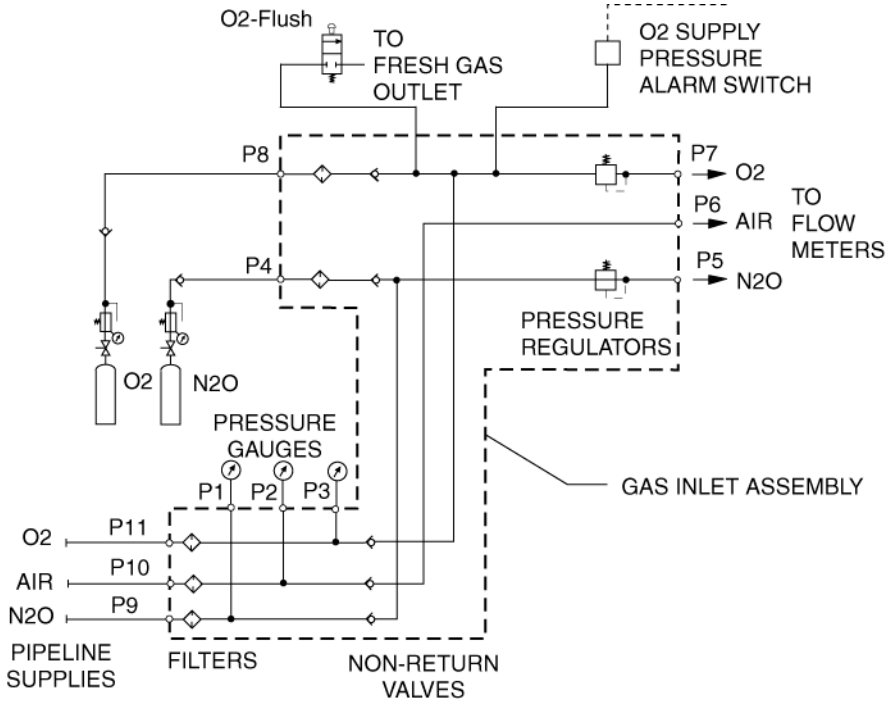

Figure 9 Gas Box Function Diagram, part 1

If the O2 flush button is pressed, oxygen is delivered to the fresh gas outlet. The fresh-gas ejector prevents the fresh gas from flowing back into the anesthetic vaporizer. This avoids an increase in the anesthetic gas concentration.

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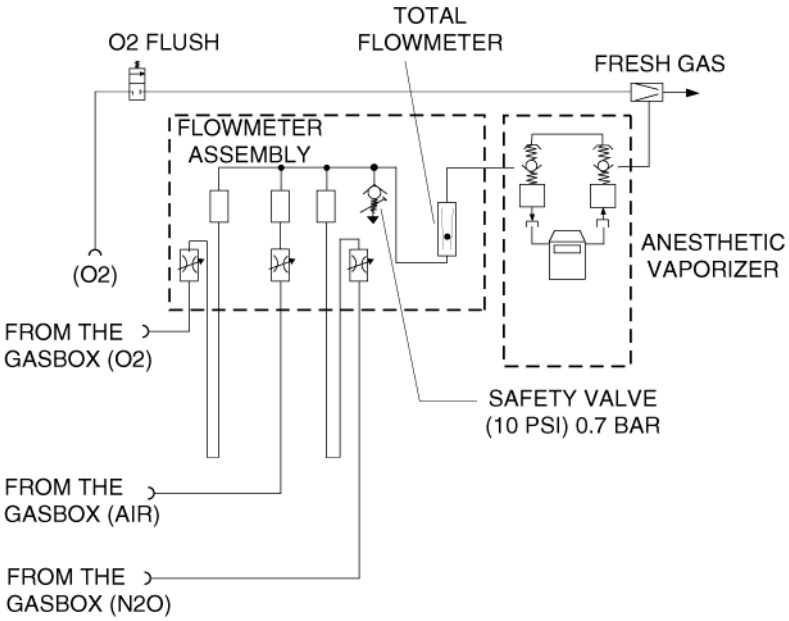

Figure 10 Gas Box Function Diagram, part 2

6 SORC (Sensitive Oxygen Ratio Controller)

The SORC is a control element that functions like an N2O shut-off device and ensures a vital O2 concentration in the fresh gas. In the event of an O2 shortage, the SORC limits the N2O flow such that the O2 concentration in the fresh gas does not decrease below 23 vol.%.

If the O2 flow control valve is closed or if the O2 flow is lower than or equal to 200 mL/min, the SORC interrupts the N2O flow.

N2O can be added when the O2 flow is approx. 300 mL/min. In this case, the SORC also prevents O2 concentrations below 23 vol.%.

The SORC bypass allows O2 to bypass the restrictor in the SORC when O2 flows above 10 L/min. are needed.

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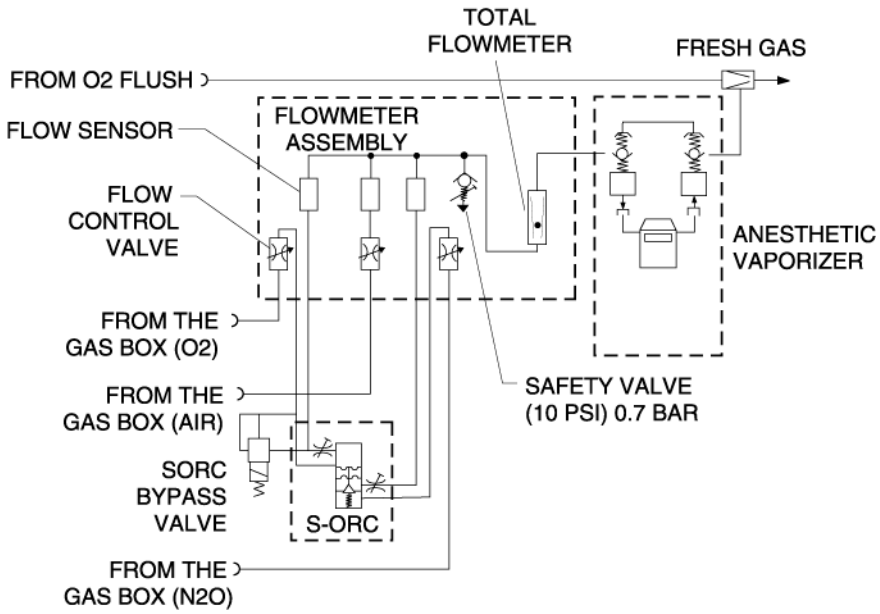

Figure 11 SORC function diagram, part 1

The flow control valves are used to adjust the O2 and N2O flows.

Restrictors located at the outlets of the SORC generate back-pressures. These back-pressures exert a force on the control diaphragms of the SORC. The O2 back-pressure opens the SORC. The N2O back-pressure closes the SORC. The pressure ratio at the control diaphragm affects the N2O flow.

The restrictors and the spring tension are dimensioned such that a minimum concentration of 23 vol.% O2 is always ensured. The maximum O2 flow is approx. 12 L/min.

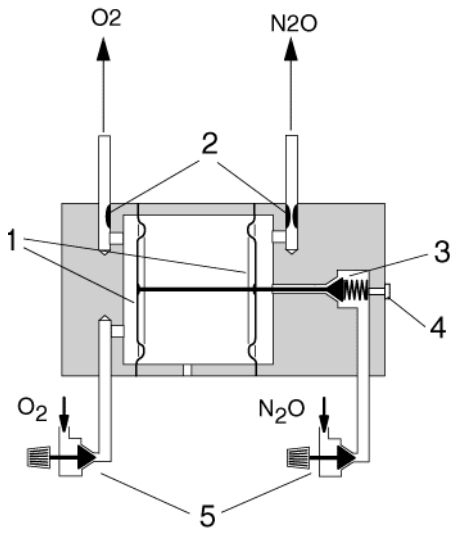

Figure 12 SORC function diagram, part 2, for legend see Table 5

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Table 5 Legend to Figure 12

No.	Name
1	Control Diaphragms
2	Restrictors
3	N2O Check Valve
4	Operating-Point Adjusting Screw
5	Flow Control Valves

7 Compact Breathing System, Cosy II

The Cosy II compact breathing system allows various modes of patient ventilation:

– manual and spontaneous breathing
– volume controlled breathing
– pressure controlled breathing

The lever style APL valve (adjustable pressure limiting valve) has a selector which can be used to toggle between “MAN” and “SPONT”.

In the “MAN” position, the compact breathing system is closed to atmosphere. This position is used for manual ventilation of the patient. The APL valve opening pressure can be adjusted from 5 to 70 cmH2O.

In the “SPONT” position the APL valve is open to atmosphere. This position is used for spontaneous breathing.

The pressure limit (Pmax) can also be adjusted (through front panel interface) during volume control from 15 cmH2O to 70 cmH2O using the control box and the PEEP Pmax valve.

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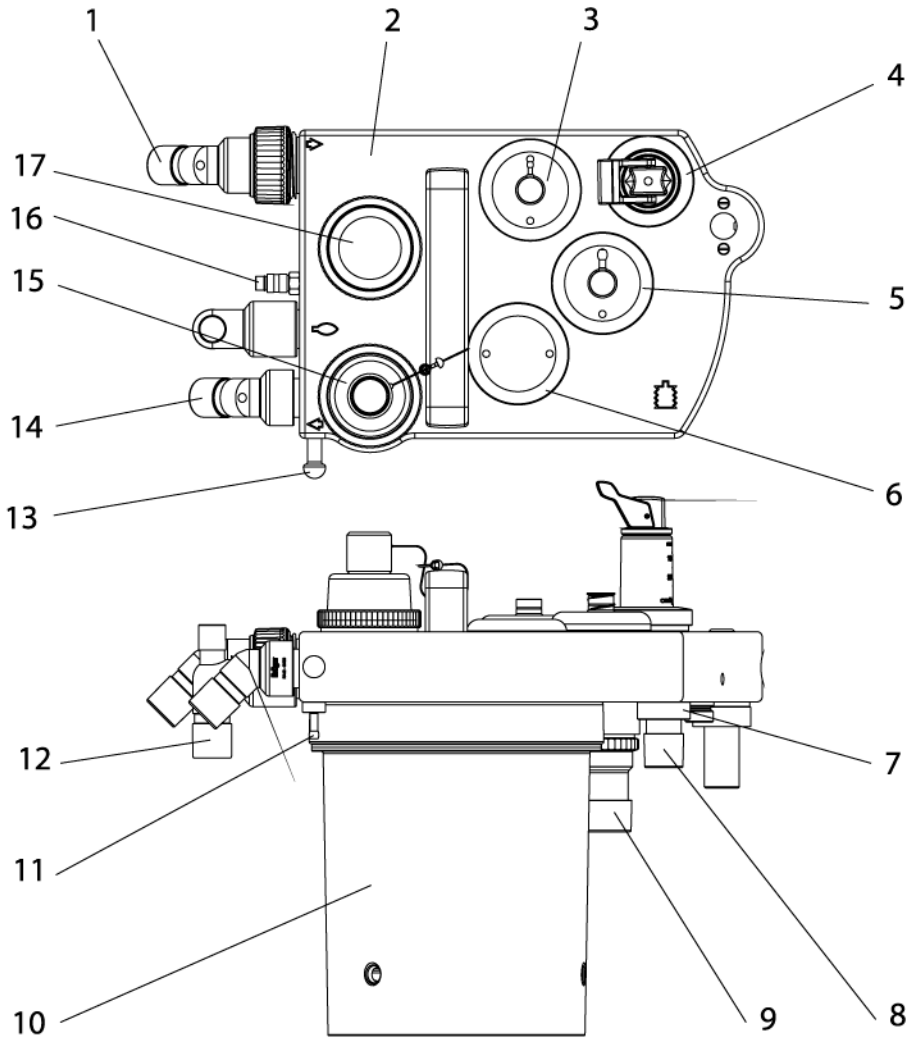

Figure 13 Compact breathing system, CosyII - Typical for P/N 4116398 or 4117529, for legend see Table 6

Table 6 Legend to Figure 13

No.	Name
1	Expiratory port
2	Flow sensor (Spirolog)
3	PEEP/Pmax valve
4	MAN/SPONT APL Valve
5	APL Bypass valve
6	Fresh-gas decoupling valve
7	Fresh-gas port
8	Ventilator port
9	Anesthetic gas scavenging port
10	Absorber

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No.	Name
11	Pressure sensor connector
12	Breathing bag terminal and Y-piece plug
13	Breathing bag hook
14	Inspiratory port
15	Inspiratory valve and O2 sensor port
16	Exhaust port, anesthetic monitor return (non-U.S. systems only)
17	Expiratory valve

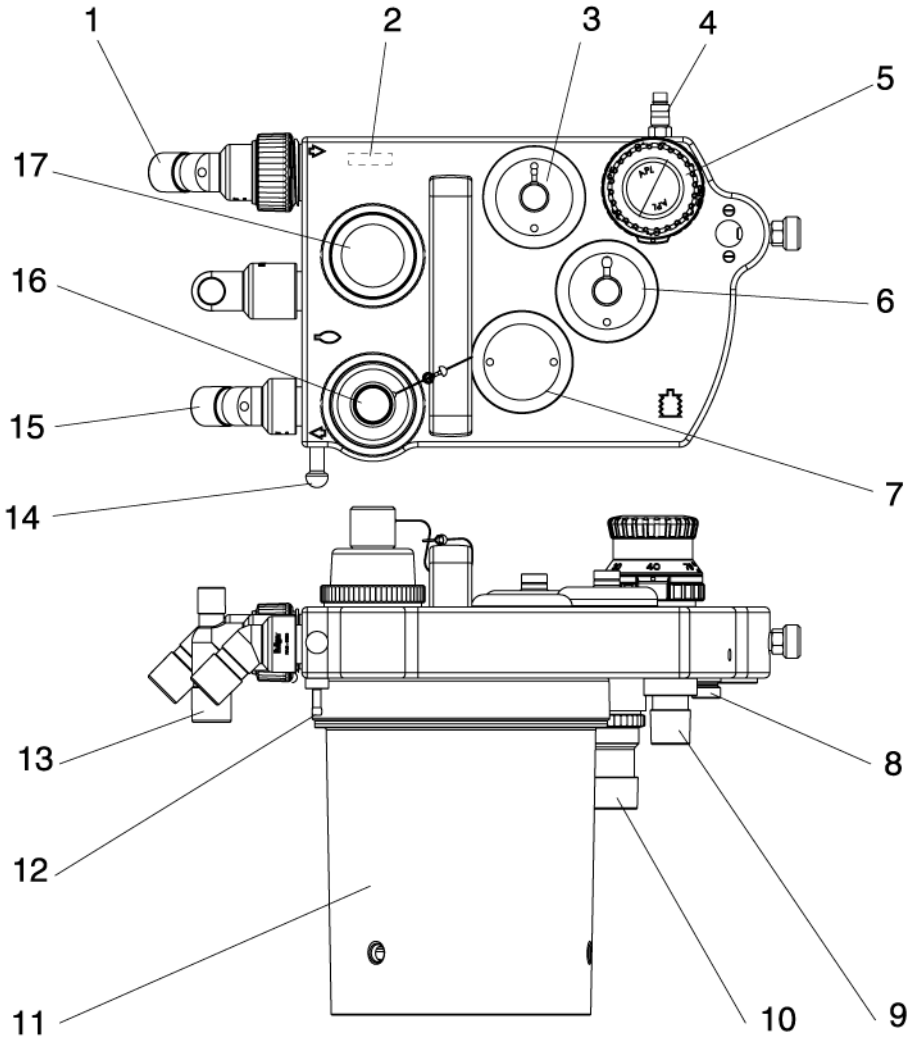

Figure 14 Compact breathing system, CosyII - Typical for P/N 41187378 or 4118379, for legend see Table 7

Table 7 Legend to Figure 14

No.	Name
1	Expiratory port

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No.	Name
2	Flow sensor (Spirolog)
3	PEEP/Pmax valve
4	Exhaust port, anesthetic monitor return (non-U.S. systems only)
5	MAN/SPONT APL Valve
6	APL Bypass valve
7	Fresh-gas decoupling valve
8	Fresh-gas port
9	Ventilator port
10	Anesthetic gas scavenging port
11	Absorber
12	Pressure sensor connector
13	Breathing bag terminal and Y-piece plug
14	Breathing bag hook
15	Inspiratory port
16	Inspiratory valve and O2 sensor port
17	Expiratory valve

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7.1 Ventilation Mode

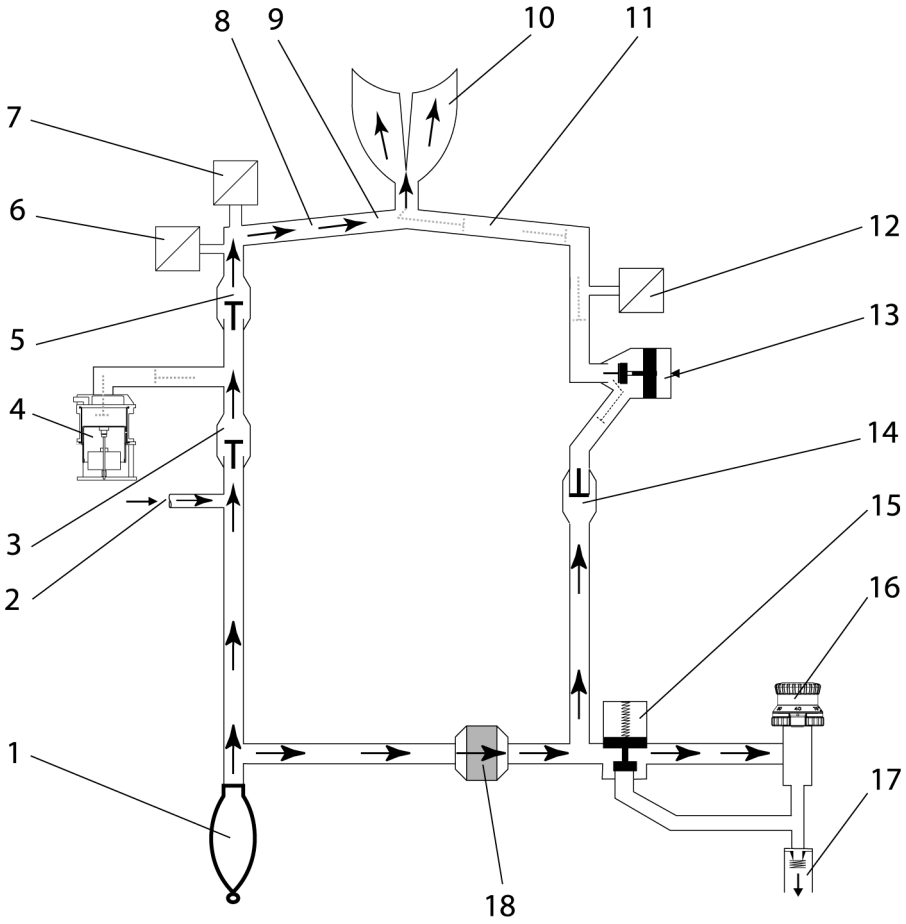

Figure 15 Function diagram of Ventilation Mode, for legend see Table 8

Table 8 **Legend to Figure 15, Figure 16, Figure 17, Figure 18, Figure 19, Figure 20, Figure 21, Figure 22, Figure 23, Figure 24, Figure 25, Figure 26, Figure 27**

No.	Name
1	Breathing bag
2	Fresh gas inlet
3	Fresh gas decoupler
4	Ventilator
5	Inspiratory valve
6	Pressure sensor
7	Oxygen sensor
8	Inspiratory hose
9	Y-piece
10	Lung
11	Expiratory hose
12	Flow sensor

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No.	Name
13	PEEP/Pmax valve
14	Expiratory valve
15	APL Bypass valve
16	APL Valve
17	Exhaust valve
18	Absorber

7.2 Function Description: Manual Ventilation

Manual Ventilation: General

During manual ventilation, the APL valve is set to the “MAN” position. The patient system safety valve is activated. The piston of the ventilator is in the upper end position in order to reduce the volume of the ventilator.

The position numbers mentioned in this chapter refer to Figure 16 and Figure 17.

Manual Ventilation: Inspiration

During inspiration, expiratory valve **14** remains closed. When the clinician compresses the breathing bag **1** the gas mixture (expiratory gas and fresh gas **2**) flows through the fresh-gas decoupling valve **3**, the inspiratory valve **5**, the O2 sensor **7**, the inspiratory hose **8**, and the Y-piece **9** into the patient’s lung **10**. The pressure sensor **6** measures the airway pressure. The APL valve **16** limits the ventilation pressure. Any excess amount of the gas mixture flows through the APL valve and the non-return valve **17** to the anesthetic gas scavenging system.

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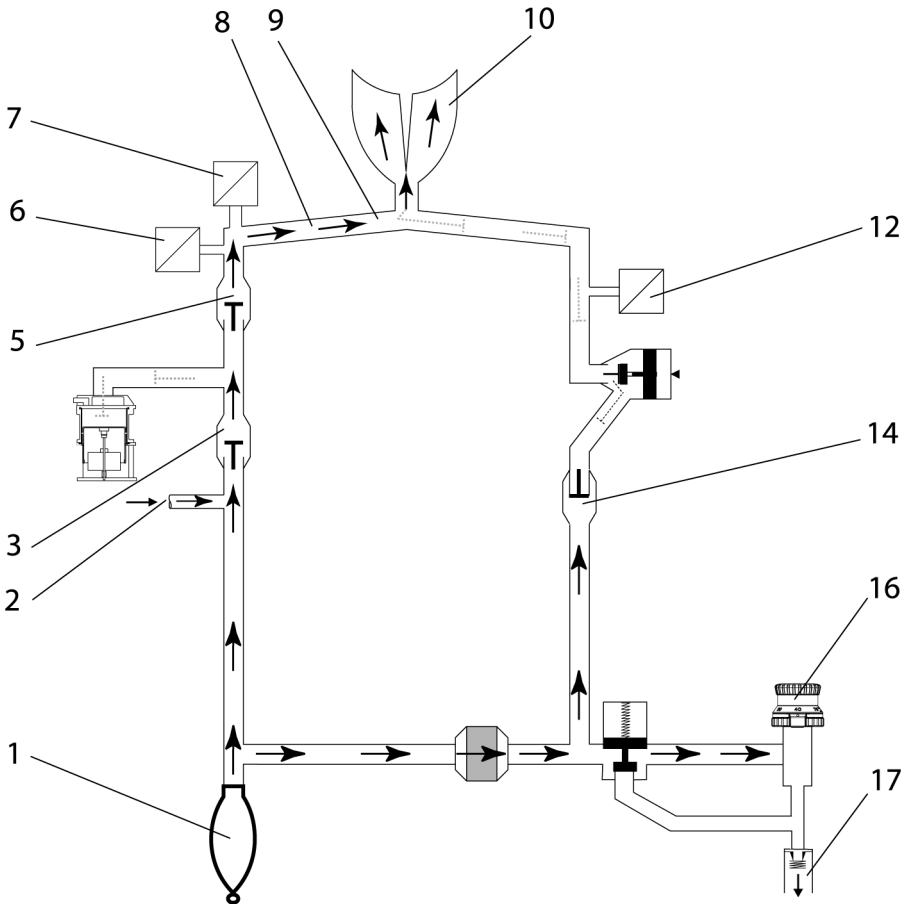

Figure 16 Manual ventilation (inspiration) - Typical for Breathing System P/N4116398 or 4117529, for legend see Table 8

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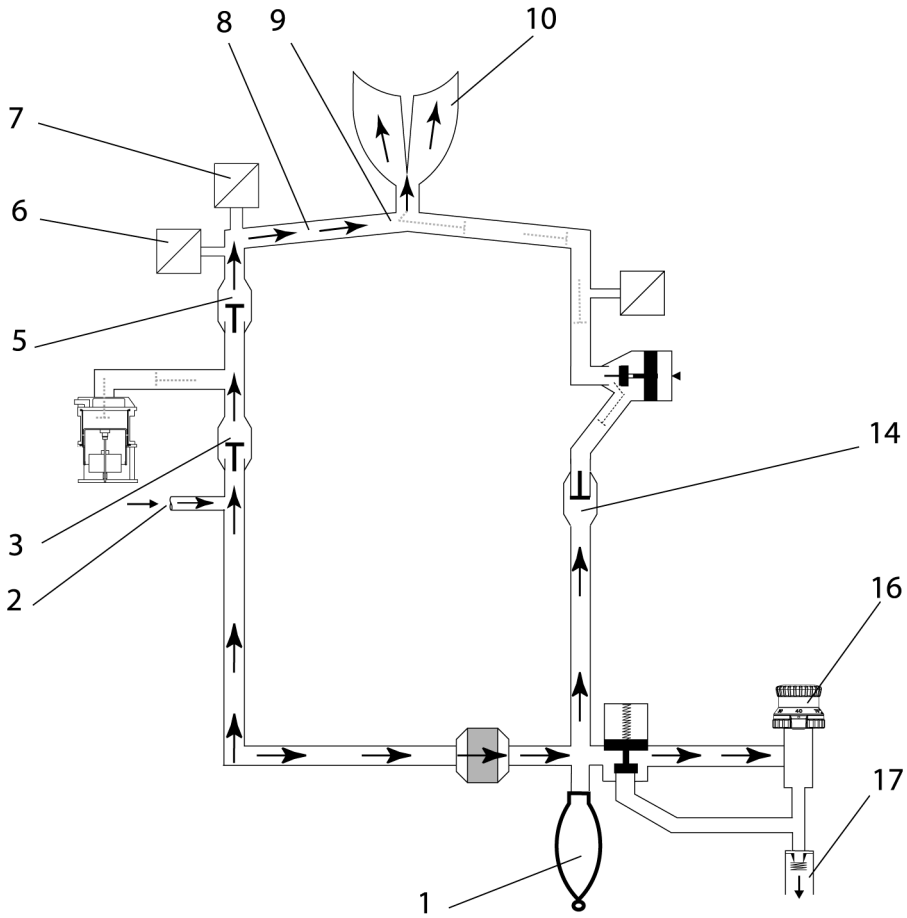

Figure 17 Manual ventilation (inspiration) - Typical for Breathing System P/N 4118378 or 4118379, for legend see Table 8

Manual Ventilation: Expiration - Typical for Breathing System P/N 4116398 or 4117529

During expiration, the inspiratory valve remains closed and thus prevents the expiratory gas from flowing back into the inspiratory branch.

The position numbers mentioned in this chapter refer to Figure 18.

After releasing the breathing bag **1**, the expiratory gas from the lung **10** flows through the expiratory hose **11**, the flow sensor **12**, the PEEP/Pmax valve **13**, the expiratory valve **14**, and through the absorber **18** into the breathing bag. At the same time, new fresh gas **2** flows into the breathing bag.

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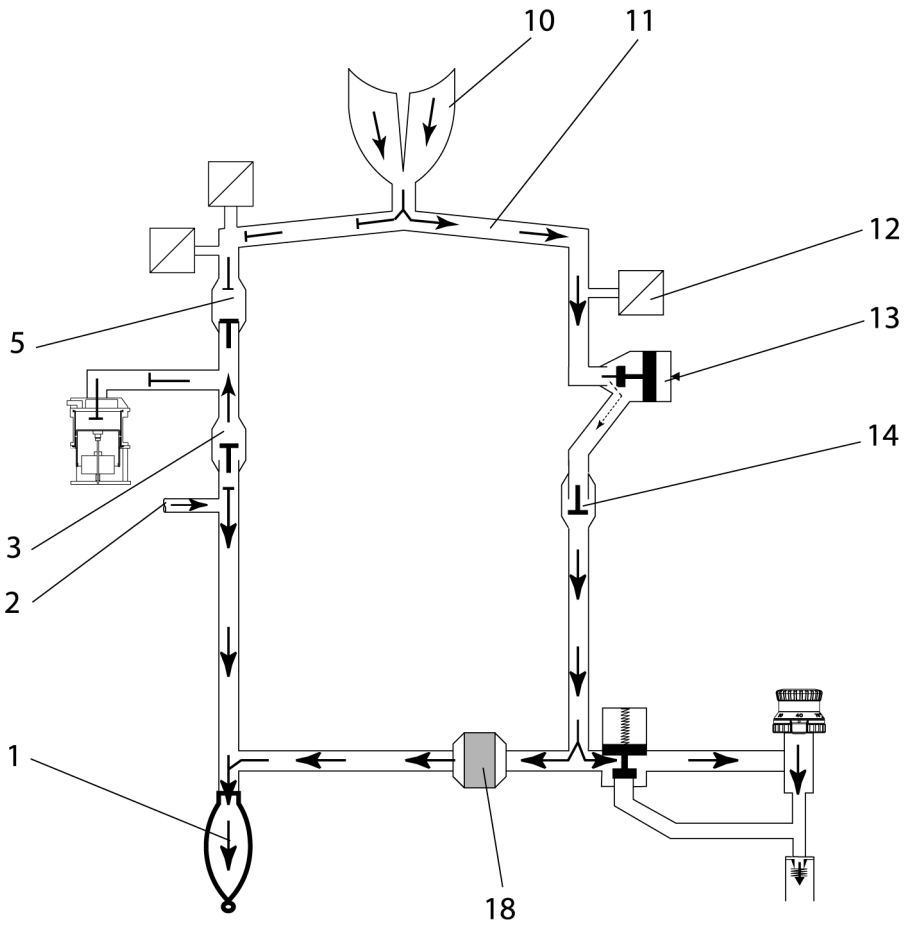

Figure 18 Manual ventilation (expiration) - Typical for Breathing System P/N 4116398 or 4117529, for legend see Table 8

Manual Ventilation: Expiration - Typical for Breathing System P/N 4118378 or 4118379

During expiration, the inspiratory valve remains closed and thus prevents the expiratory gas from flowing back into the inspiratory branch.

The position numbers mentioned in this chapter refer to Figure 19.

After releasing the breathing bag **1**, the expiratory gas from the lung **10** flows through the expiratory hose **11**, the flow sensor **12**, the PEEP Pmax valve **13**, the expiratory valve **14**, onto the breathing bag and through the absorber **18**. At the same time, new fresh gas **2** flows into the breathing bag.

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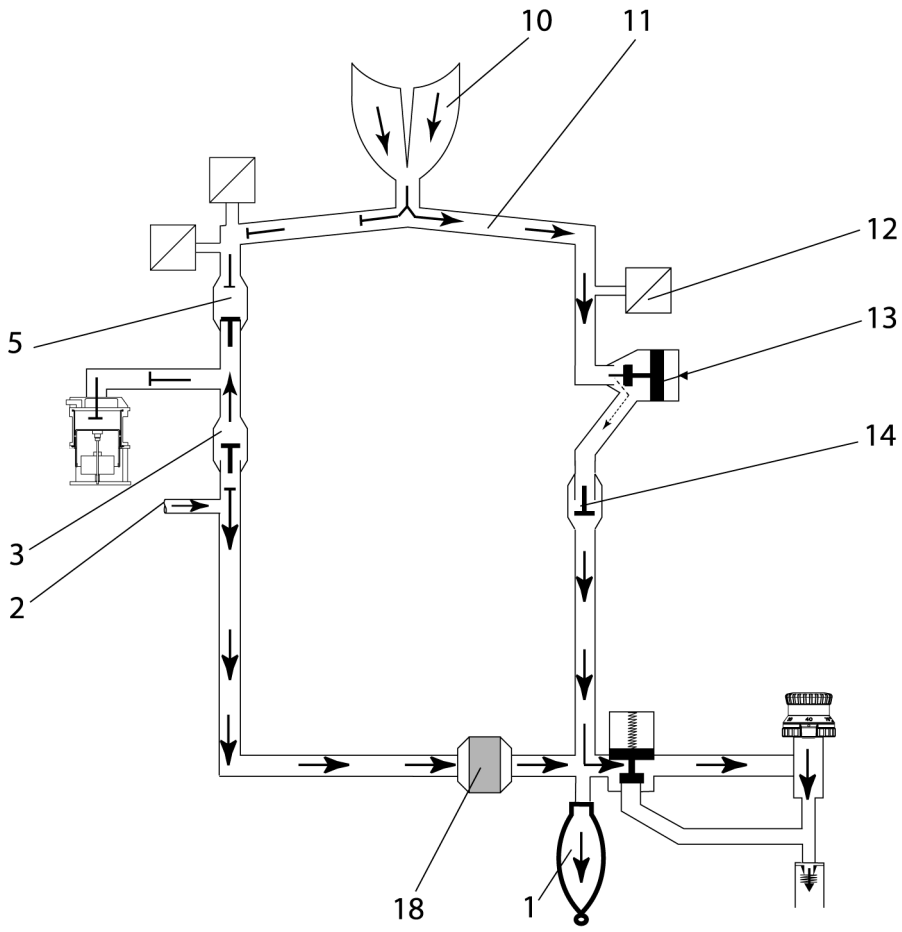

Figure 19 Manual ventilation (expiration) -Typical for Breathing System P/N 4118378 or 4118379, for legend see Table 8

7.3 Function Description: Spontaneous Breathing

Spontaneous Breathing: General

A prerequisite for spontaneous breathing is that the patient is supplied with a sufficient amount of fresh gas. The APL valve selector must be set to the “SPONT” position. No pressure builds up in the compact breathing system.

Spontaneous Breathing: Inspiration

During inspiration, the expiratory valve remains closed thus preventing rebreathing of expiratory gas containing CO2.

The position numbers mentioned in this chapter refer to Figure 20 and Figure 21.

The patient inhales the gas mixture (expiratory gas and fresh gas **2**) from the breathing bag **1**. The gas mixture flows through the fresh-gas decoupling valve **3**, the inspiratory valve **5**, the O2 sensor **7**, the inspiratory hose **8**, and through the Y-piece **9** into the lung **10**. The pressure sensor **6** measures the airway pressure.

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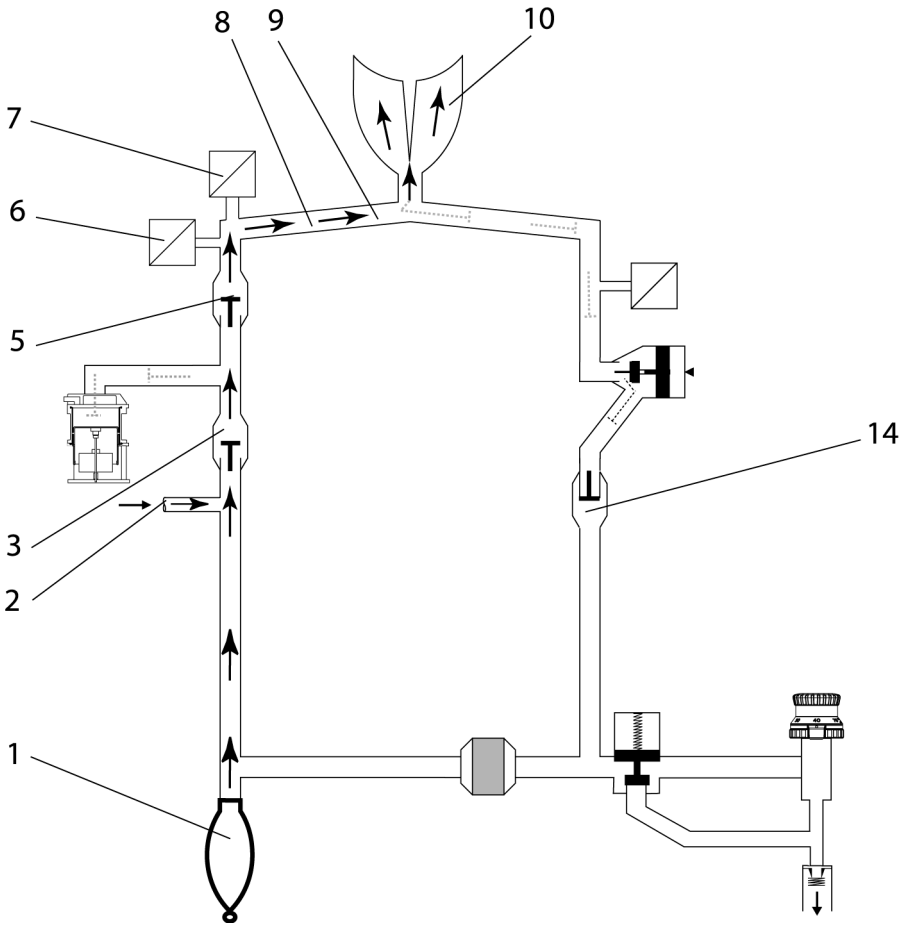

Figure 20 Spontaneous breathing (inspiration) - Typical for Breathing System P/N 4116398 or 4117529, for legend see Table 8

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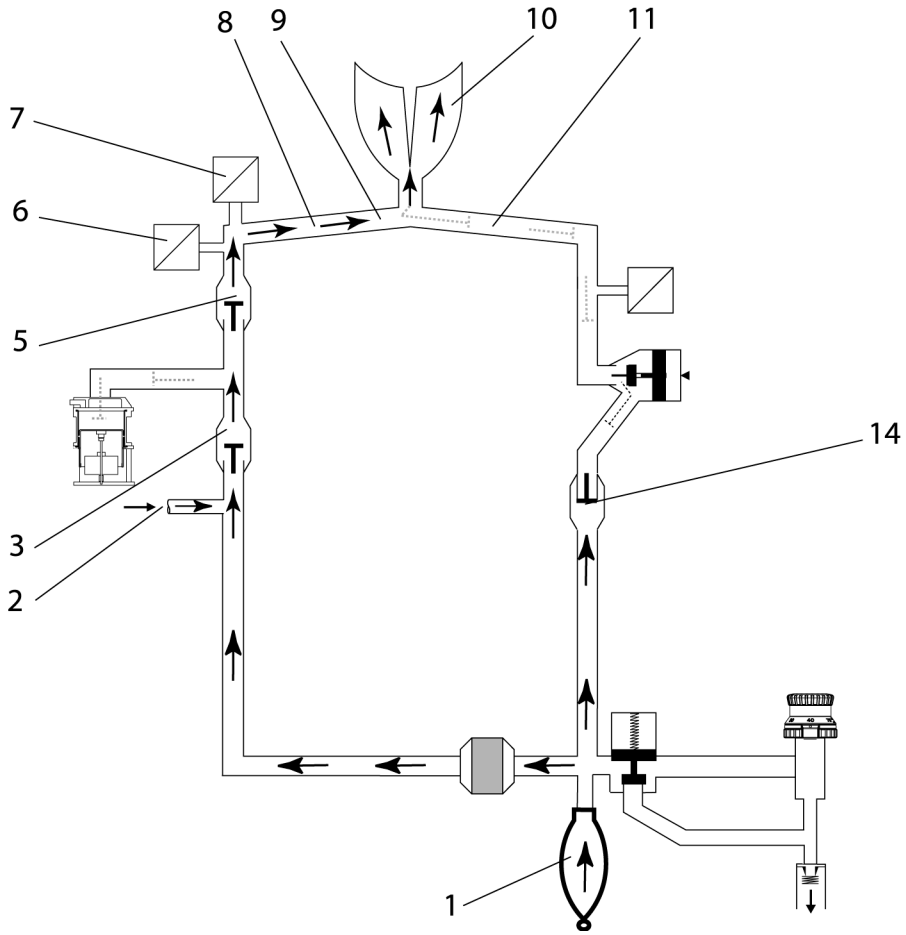

Figure 21 Spontaneous breathing (inspiration - Typical for Breathing System P/N 4118378 or 4118379, for legend see Table 8

Spontaneous Breathing: Expiration - Typical for Breathing System P/N 4116398 or 4117529

During expiration, the inspiratory valve remains closed thus preventing the expiratory gas from flowing back into the inspiratory branch.

The position numbers mentioned in this chapter refer to Figure 22.

The APL valve **16** is open, regardless of its pressure setting.

The expiratory gas flows from the lung **10** through the expiratory hose **11**, the flow sensor **12**, the PEEP control valve **13**, the expiratory valve **14**, and through the absorber **18** into the breathing bag **1**. At the same time, new fresh gas **2** flows into the breathing bag.

When the breathing bag is full, any excess gas mixture flows through the non-return valve **17** into the anesthetic gas scavenging system.

The CO2 is scrubbed from the expiratory gas by the soda lime contained in the absorber. The fresh gas replaces the anesthetic and oxygen taken up by the patient.

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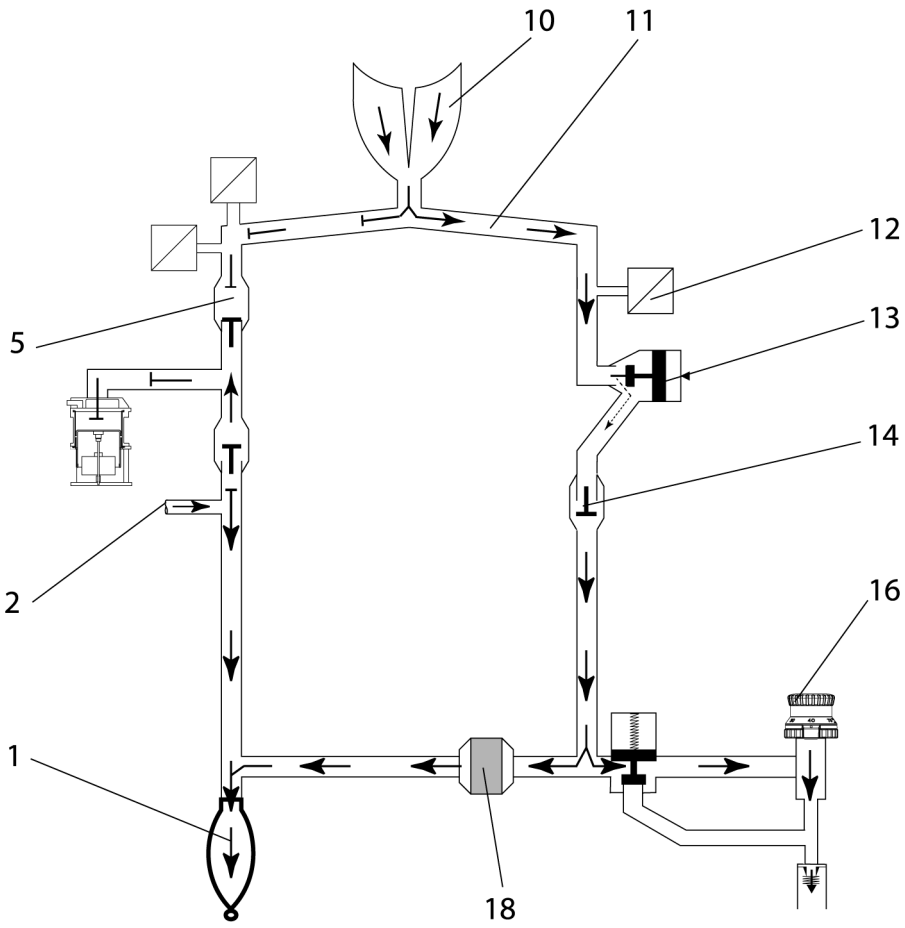

Figure 22 Spontaneous breathing (expiration) - Typical for breathing System P/N 4116398 or 4117529, for legend see Table 8

Spontaneous Breathing: Expiration - Typical for Breathing System P/N 4118378 or 4118379

During expiration, the inspiratory valve remains closed thus preventing the expiratory gas from flowing back into the inspiratory branch.

The position numbers mentioned in this chapter refer to Figure 23.

The APL valve **16** is open, regardless of its pressure setting.

The expiratory gas flows from the lung **10** through the expiratory hose **11**, the flow sensor **12**, the PEEP control valve **13**, the expiratory valve **14**, the breathing bag **1**, and through the absorber **18**. At the same time, new fresh gas **2** flows into the breathing bag.

When the breathing bag is full, any excess gas mixture flows through the non-return valve **17** into the anesthetic gas scavenging system.

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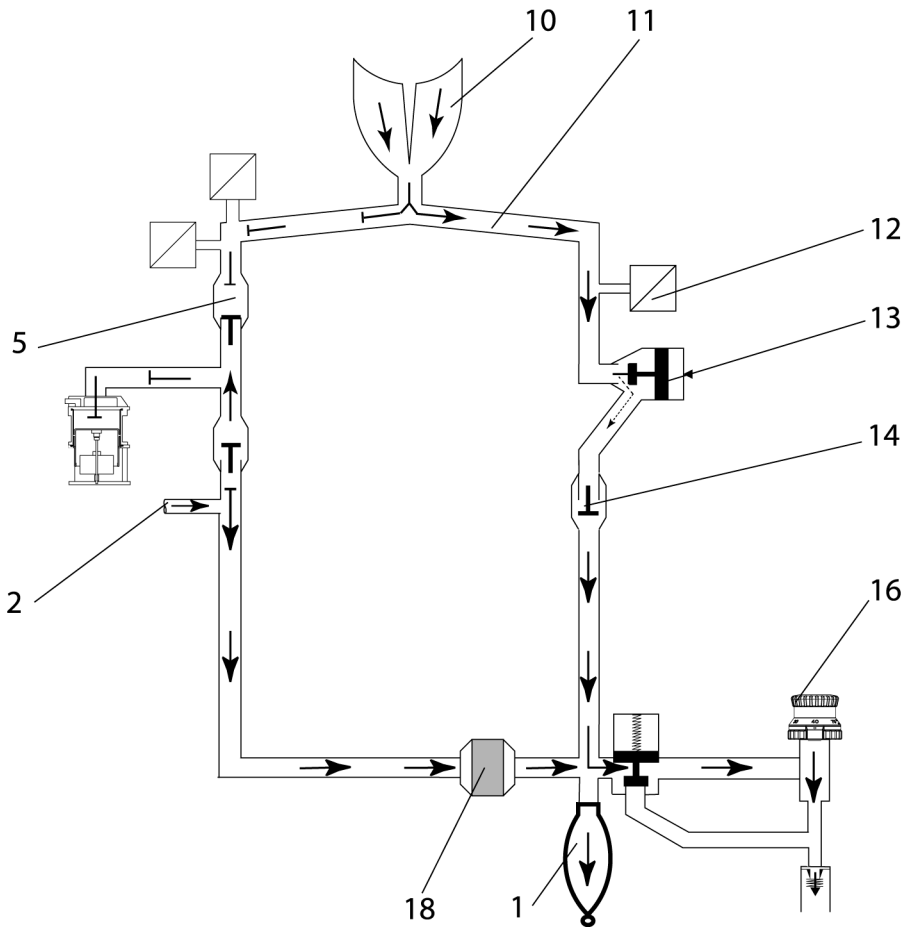

Figure 23 Spontaneous breathing (expiration) - Typical for Breathing System P/N 4118378 or 4118379, for legend see Table 8

7.4 Function Description: Volume/Pressure Mode Ventilation

Volume Control Mode: General

A prerequisite for volume control is that the patient is supplied with a sufficient amount of fresh gas.

The APL bypass valve opens in volume mode, allowing excess gas to be vented to the scavenging system regardless of the MAN-SPONT valve setting.

The safety valve of the patient system makes sure that no pressures greater than 75 cmH2O build up in the system.

During ventilation, the pressure limit (Pmax) can be adjusted at the user interface.

Volume/Pressure Control Mode: Inspiration

During inspiration, the PEEP/Pmax valve remains closed. The control pressure present at the PEEP/Pmax valve varies with the set pressure limit (Pmax).

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The position numbers mentioned in this chapter refer to Figure 24 and Figure 25.

The pressure generated by the ventilator's piston **4** closes the fresh-gas decoupling valve **3**. The gas mixture (expiratory gas and fresh gas **2**) flows through the inspiratory valve **5**, the O2 sensor **7**, the inspiratory hose **8**, and through the Y-piece **9** into the lung **10**. The pressure sensor **6** measures the airway pressure. The ventilation pressure cannot exceed the pressure limit (Pmax) set on the control box because the PEEP/Pmax valve **13** opens. The fresh gas then fills the breathing bag **1**.

Any excess fresh gas flows through the open APL bypass valve **15**, and through the non-return valve **17** into the anesthetic gas scavenging system.

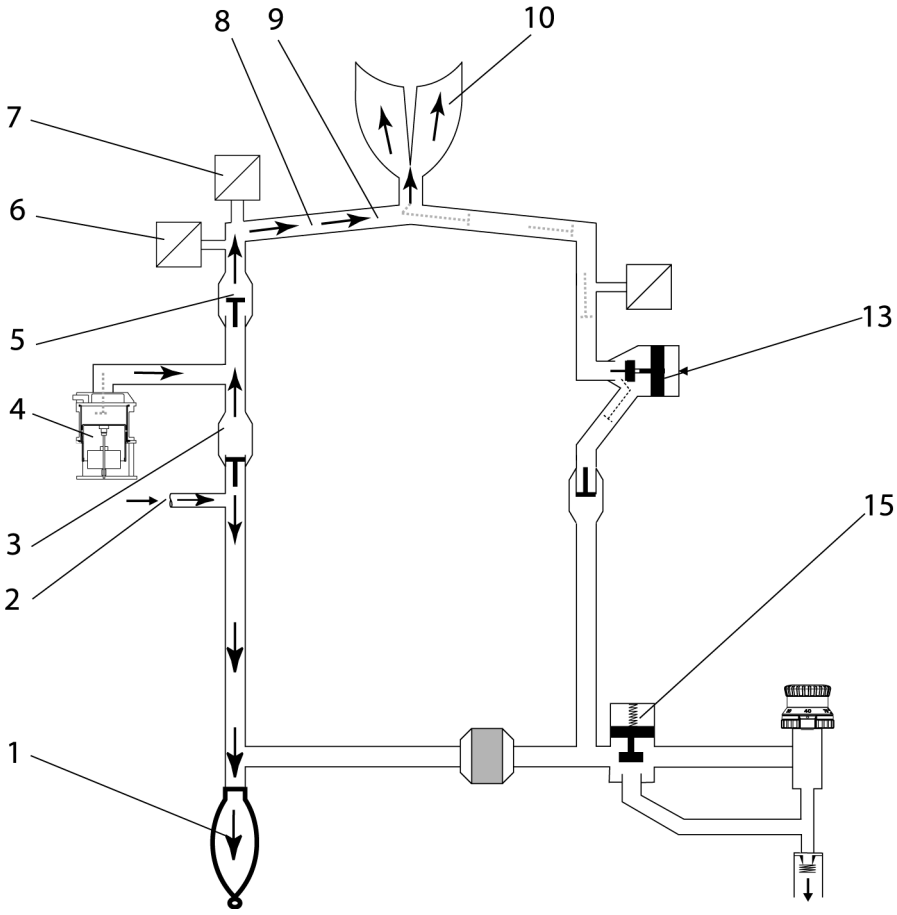

Figure 24 Volume control ventilation (inspiration) - Typical for Breathing System P/N 4116398 or 4117529, for legend see Table 8

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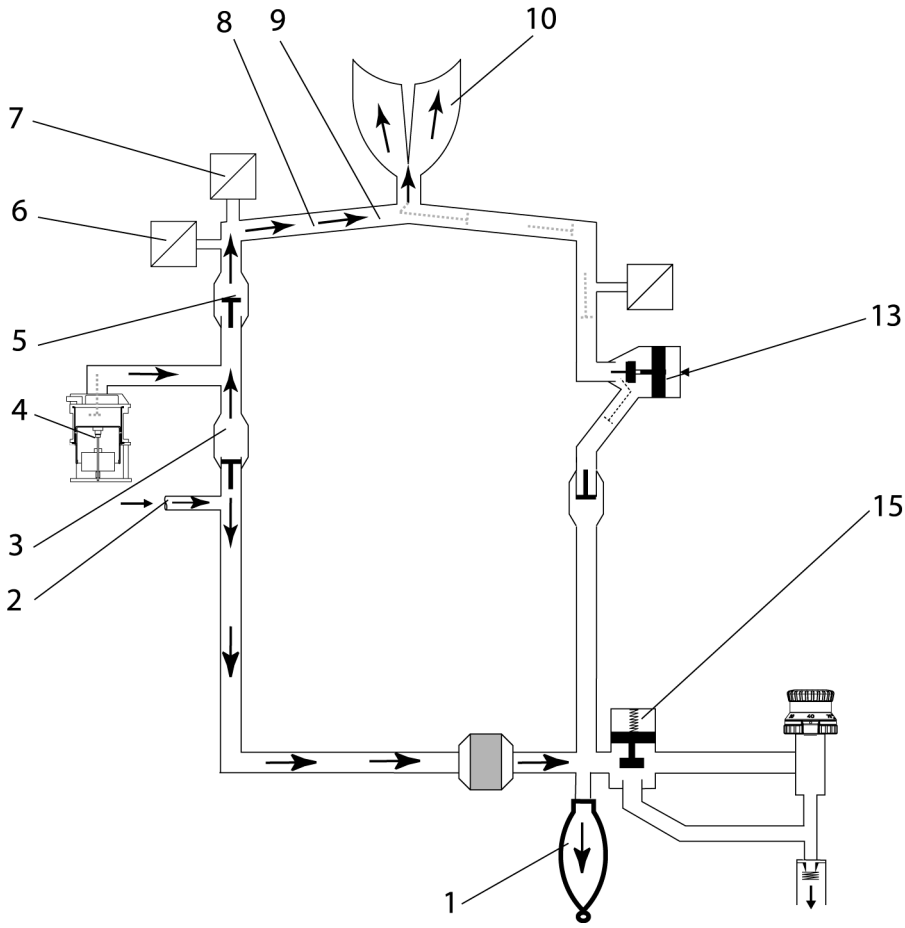

Figure 25 Volume control ventilation (inspiration) - Typical for Breathing System P/N 4118378 or 4118379, for legend see Table 8

Volume/Pressure Control Mode: Expiration

During expiration, the inspiratory valve remains closed thus preventing rebreathing into the inspiratory branch.

The position numbers mentioned in this chapter refer to Figure 26 and Figure 27.

The expiratory gas from the lung **10** flows through the expiratory hose **11**, the flow sensor **12**, the PEEP/Pmax valve **13**, the expiratory valve **14**, and through the absorber **18** back into the breathing bag **1** mixing with fresh gas **2** also flowing into the breathing bag.

The ventilator's piston **4** moves back drawing the gas mixture needed for the next inspiration into the piston space.

Any excess fresh-gas flows through the APL bypass valve **15**, and through the non-return valve **17** into the anesthetic gas scavenging system.

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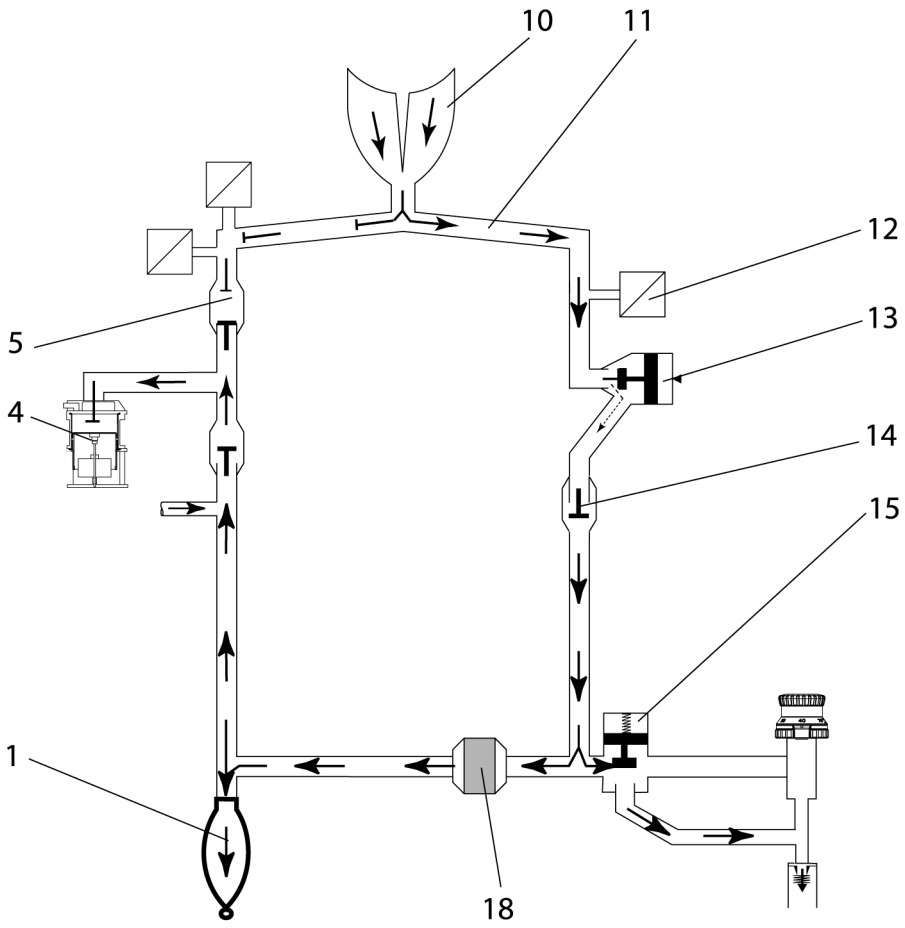

Figure 26 Volume control ventilation (expiration) - Typical for breathing System P/N 4116398 or 4117529, for legend see Table 8

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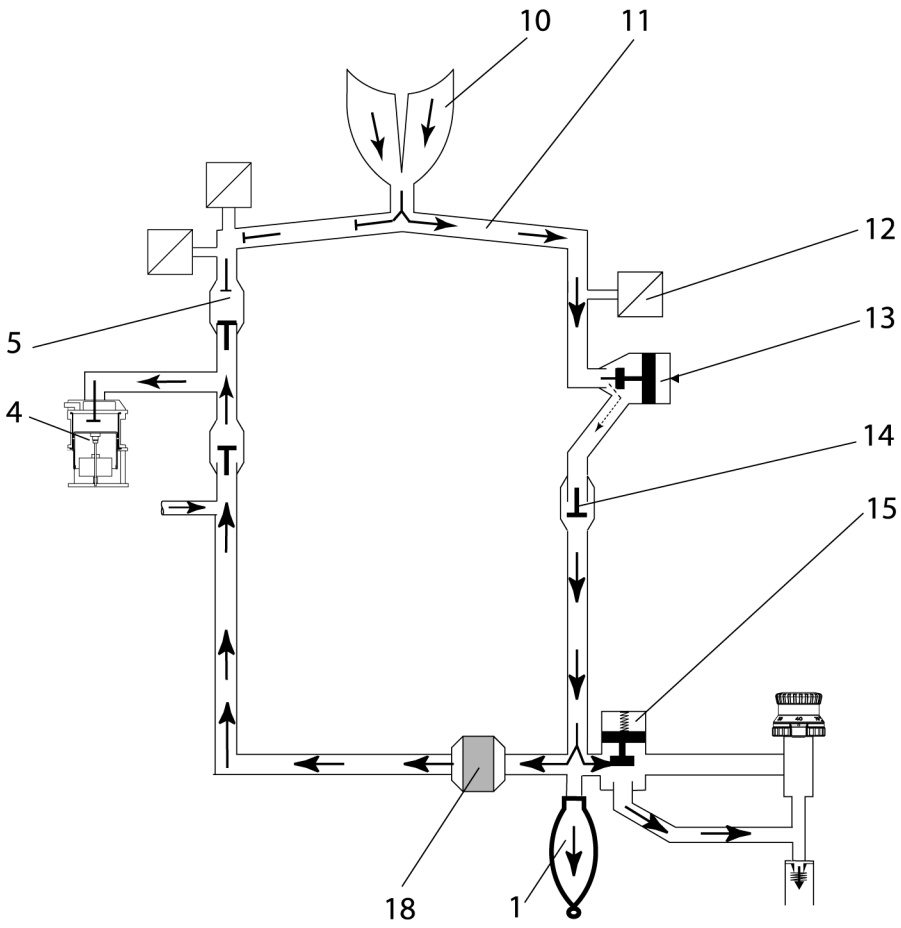

Figure 27 Volume control ventilation (expiration) - Typical for Breathing System P/N 4118378 or 4118379, for legend see Table 8

7.5 Cosy II Absorber

The absorber canister is filled with fresh soda lime. The soda lime scrubs CO2 from the respiratory expired gas.

Expired soda lime changes its color. The soda lime must be replaced when two thirds of the soda lime in the absorber canister is discolored.

8 Ventilator

The ventilator is located in a swing-out compartment at the left side of the Fabius GS. A hose terminal is provided on the left side of the compartment for connection to the breathing system. Fresh gas is delivered to the patient by a piston that is driven by a motor and ball-screw arrangement. A sight window on the compartment allows the operator to verify movement of the piston.

Two diaphragms (upper and lower) comprise a bag-type rolling seal that surrounds the piston. Vacuum from the pneumatic assembly (described in a later paragraph) is provided between the outside of the seal and the cylinder, to ensure proper operation of the seal during piston movement.

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During inspiration the ventilator delivers fresh gas at a given volume, pressure and frequency. These parameters are set at the control panel. Refer to the Operator's Manual for details on ventilator settings, displays and controls. During expiration, the bag-type rolling seal fills with expired gas from the patient and with fresh gas stored in the breathing bag.

Power for the ventilator motor is distributed from the control PCB. A position sensor on the ventilator signals the control PCB when the piston reaches its lower limit. An incremental encoder on the motor shaft determines the number of revolutions and provides piston travel information to the control PCB.

Ventilator pressure is monitored by a transducer on the control PCB. Should the negative pressure relief valve on the patient assembly open, a Fresh Gas Low alarm is displayed, if enabled via Service Mode.

The ventilator pressure transducer is the same type as the one used for measuring airway pressure. A hose connects the transducer's positive pressure port to a hose barb located on the top cover of the ventilator. The purpose of this transducer is to allow the software to sense when a condition exists that would cause the ventilator negative pressure relief valve to open. The threshold used by the software for this condition is indicated in the table below. In normal use the primary cause for this condition is an insufficient amount of reserve gas in the breathing bag. The operator is alerted when this condition exists, with a medium priority "FRESH GAS LOW" alarm. This alarm may be disabled via Service Mode.

Table 9 Threshold

Software Version	Threshold
US units with SW >1.20	-8 mbar
US units with SW 1.20	-3 mbar
non-US units with SW ≤1.20	-3 mbar
non-US units with SW >1.20	-8 mbar

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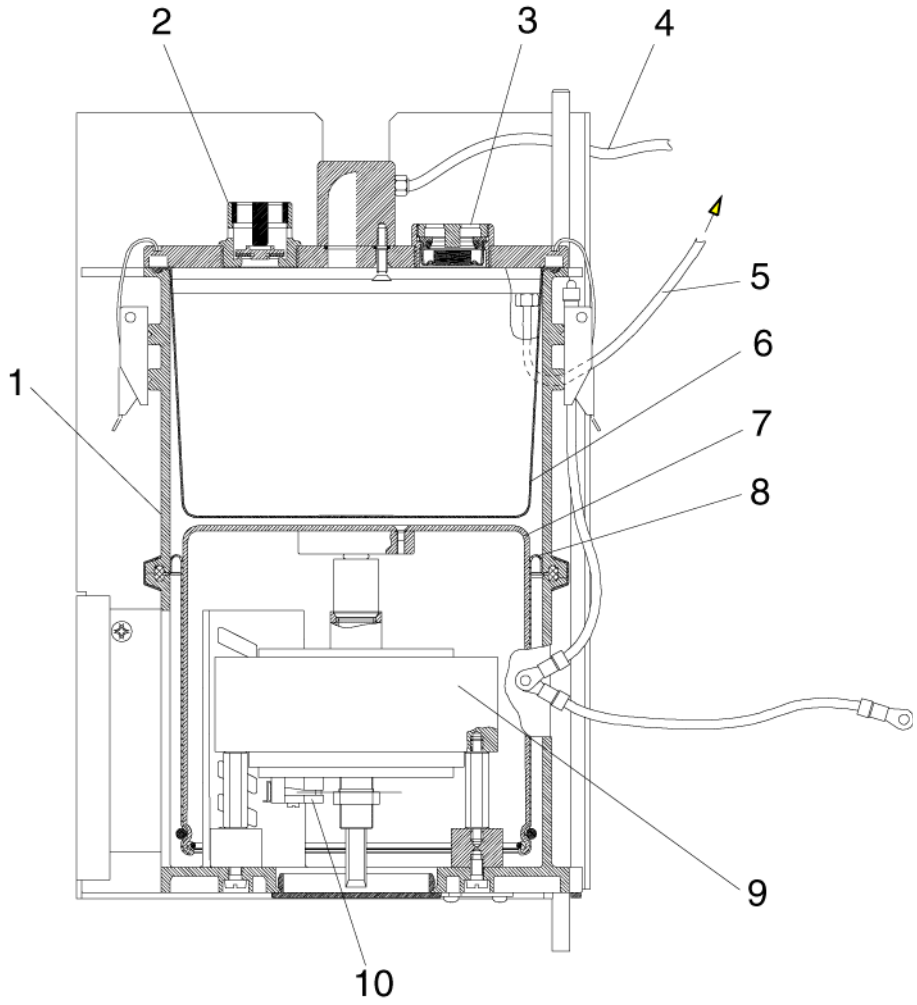

Figure 28 Ventilator (piston shown in ‘down’ position), for legend see Table 10

Table 10 Legend to Figure 28

No.	Name
1	Cylinder
2	High pressure valve
3	Negative pressure relief valve
4	Vent chamber pressure sensor line
5	Vacuum line to pneumatic assembly
6	Upper diaphragm
7	Piston
8	Lower diaphragm
9	Motor and ballscrew assembly
10	Incremental encoder

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The top of the ventilator assembly (patient system) contains two valves:

8.1 High Pressure Safety Valve

If the pressure limit control fails, the patient system high pressure safety valve limits the gas pressure. This valve is set to open at approximately 75 cmH2O.

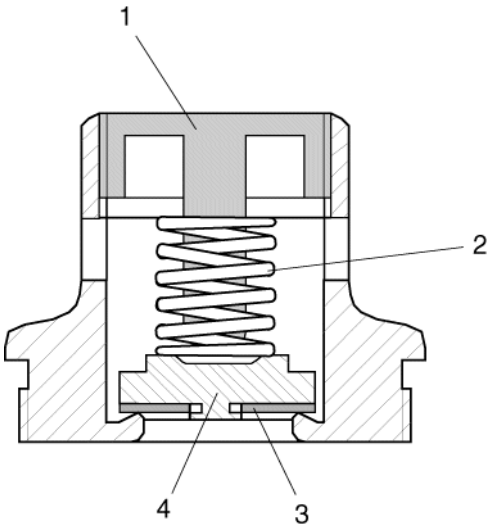

Figure 29 Sectional View of the Safety Valve, for legend see Table 11

Table 11 Legend to Figure 29

No.	Name
1	Screw
2	Spring
3	Washer
4	Valve disc

8.2 Negative Pressure Relief Valve

The negative pressure relief valve allows the patient to spontaneously breathe ambient air should the medical gas supply and/or Fabius GS fail. The opening pressure of this valve is indicated in the table below.

Table 12 Threshold

Software Version	Threshold
US units with SW >1.20	-8 mbar
US units with SW 1.20	-3 mbar
Non-US units with SW ≤1.20	-3 mbar
Non-US units with SW >1.20	-8 mbar

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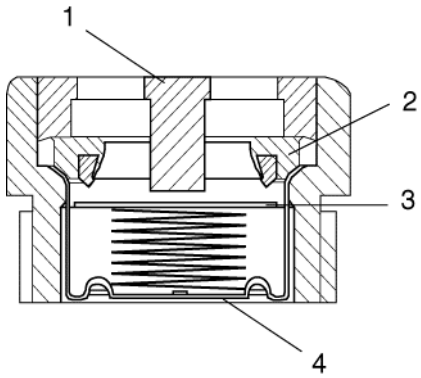

Figure 30 Sectional View of the Negative Pressure Relief Valve, for legend see Table 13

Table 13 Legend to Figure 30

No.	Name
1	Threaded ring
2	Valve seat
3	Valve disc
4	Valve cross with spring

9 Pneumatic System

The pneumatic assembly provides pressure for the PEEP valve control, and also provides vacuum for the ventilator bag-type rolling seals and the APL bypass valve control.

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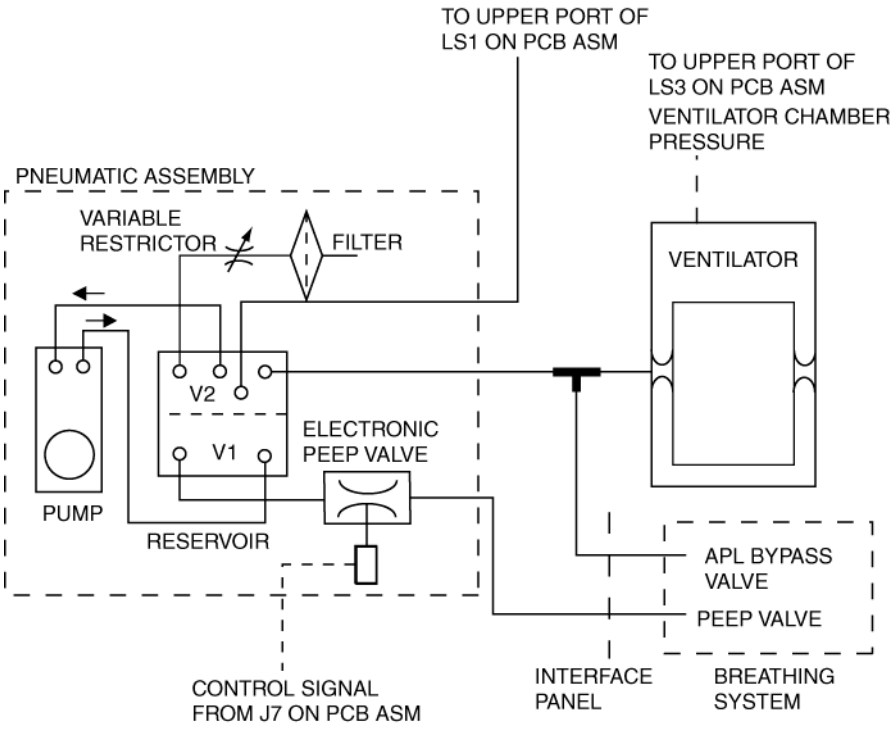

Figure 31 Pneumatic Control System Schematic

9.1 PEEP/Pmax Valve Control

When the Fabius GS is operating in the automatic mode, the pump on the pneumatic assembly is running, and the electronic PEEP valve receives a signal from the main control PCB. The amount of current supplied to the coil of the electronic PEEP valve is proportional to the PEEP value set by the operator, and controls the position of the diaphragm within the electronic PEEP valve. This then determines the control pressure applied to the proportional PEEP valve in the breathing system, which maintains the desired amount of PEEP during patient expiration. The V1 reservoir smooths out pressure variations caused by the pump. See Figure 31.

9.2 APL Bypass Valve Control

When the Fabius GS is operating in the automatic mode, the pneumatic assembly provides a vacuum signal to hold open the APL bypass valve in the breathing system. The V2 reservoir and filter provide noise damping, and the variable restrictor is used to set the vacuum level in the range of -150 to -240 cmH2O.

When the machine is operating in the Manual mode, the pump on the pneumatic assembly (and the ventilator) is stopped, and the spring-loaded APL bypass valve in the breathing system closes, directing exhaled gas through the APL valve.

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10 Electrical Block Diagram

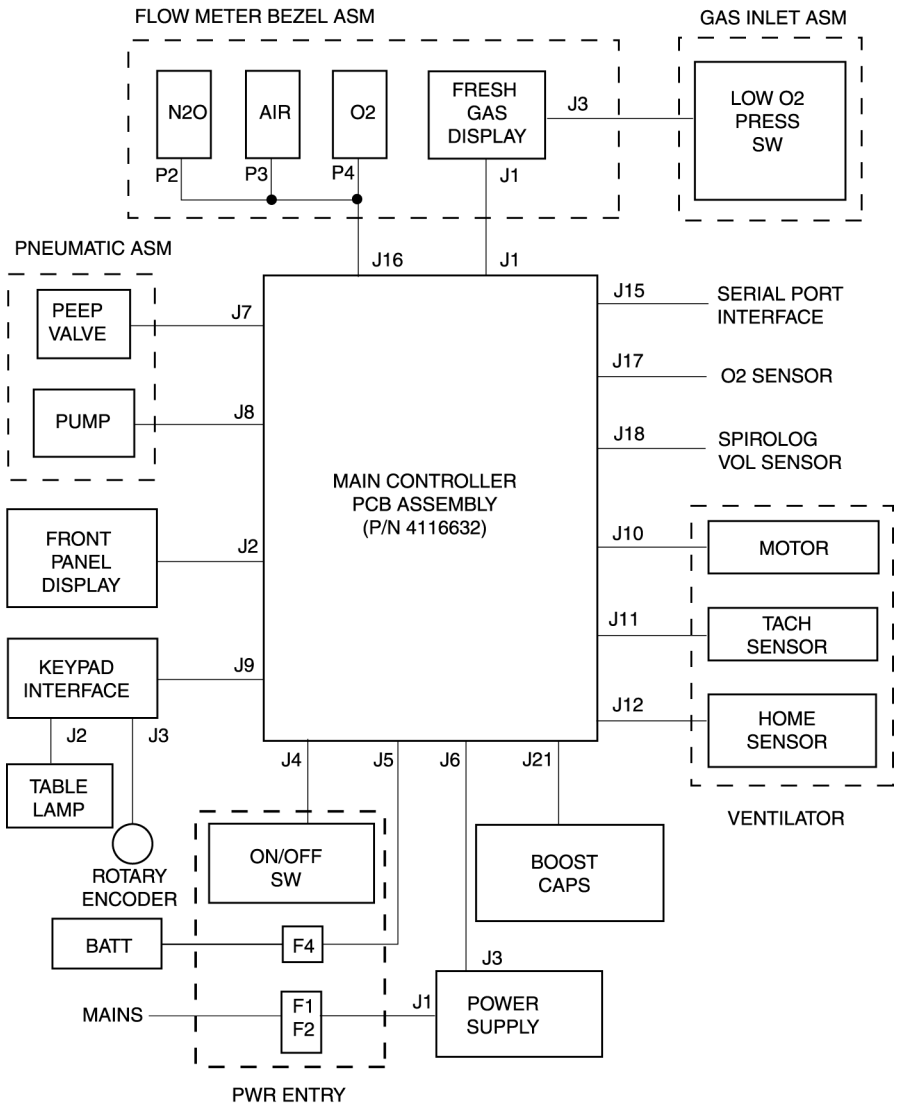

Figure 32 Electrical Block Diagram

11 Function Description: Control PCB

The control PCB provides the following functions in the Fabius GS:

11.1 Flowmeter

Receives flow rate data from the N2O, Air, and O2 flow sensors and provides fresh gas display information for these gases.

11.2 Patient Interface

Receives information from the oxygen sensor and processes it for display.

Receives flow information from the Spirolog sensor and processes it for display.

Converts airway breathing pressure to an electrical signal and processes it for display.

11.3 Ventilator

Provides ventilator motor drive, receives ventilator piston position and movement information. Provides ventilator pressure information.

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11.4 Front Panel Functions

Provides power for the display panel and LED table lamp.

Provides video signals to the display.

Receives information from the keypad and rotary encoder for making display and operating selections, setting alarm limits, and service functions.

11.5 Pneumatic Assembly Control

Provides power to the pump on the pneumatic assembly.

Provides control signal to the electronic PEEP valve on the pneumatic assembly in response to operator setting.

Monitors pump vacuum to stabilize PEEP control.

11.6 Serial Port Interface

Provides isolated port for connecting external monitors and downloading software.

11.7 Battery

Provides charging current for battery and monitors state of battery charge.

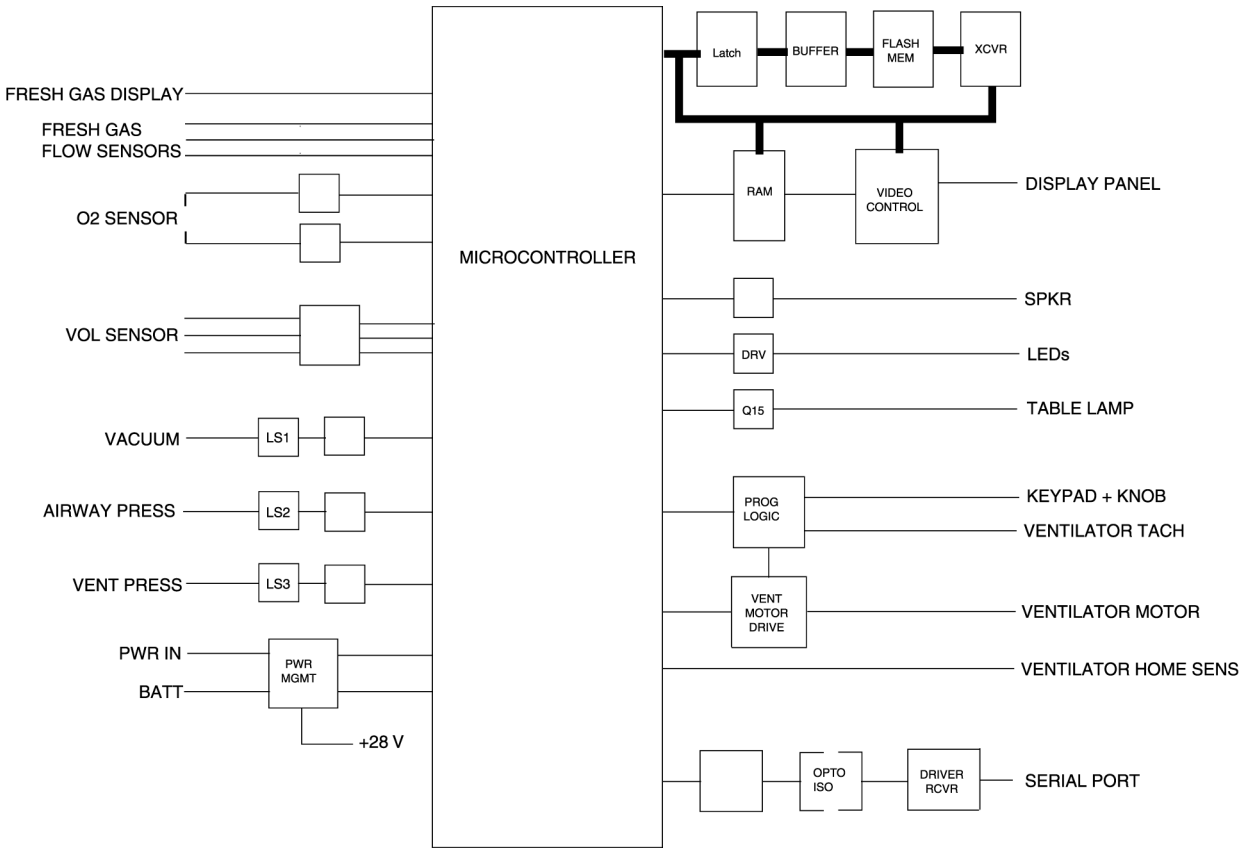

Figure 33 Controller Functional Block Diagram

12 Control Panel Assembly

The control panel assembly consists of a 320 x 240 pixel graphical display, a table lamp with six LEDs, a membrane keypad, rotary encoder and speaker.

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Data and power for the display comes from the main controller PCB via a 20-conductor ribbon cable. The keypad interface is connected to the main controller PCB by a 30-conductor ribbon cable. A block diagram of the control panel assembly is shown in the following illustration.

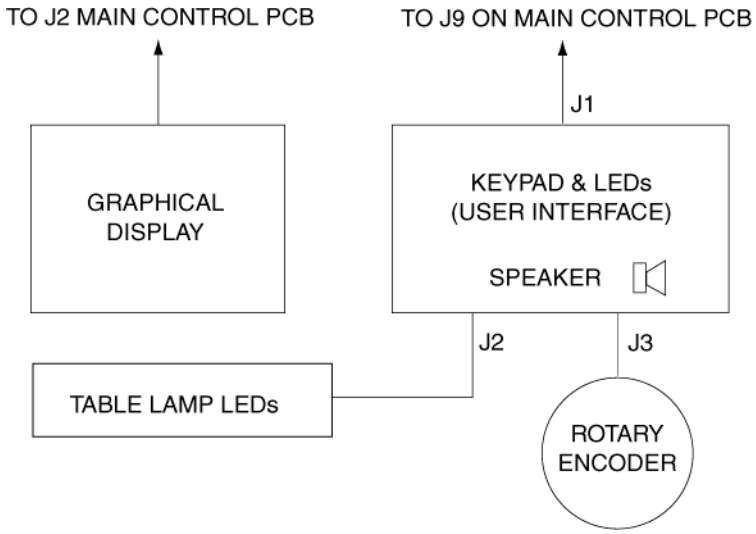

Figure 34 Control Panel Block diagram

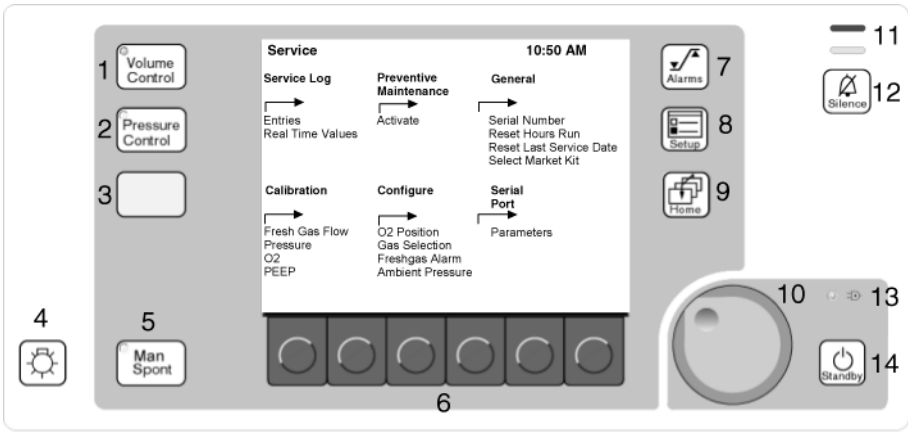

Figure 35 Fabius GS Control Panel (Main Service Screen Illustrated), for legend see Table 14

Table 14 Legend to Figure 35

Item	Function
1	Selects volume controlled ventilation mode. Refer to Operator's Manual
2	Selects pressure controlled ventilation mode. Refer to Operator's Manual
3	Reserved for future use

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Item	Function
4	Controls table lamp: Off/On
5	Places ventilator in Man Spont mode. Refer to Operator's Manual
6	Soft keys: activate the corresponding function that appears on screen above the key
7	For setting alarm limits. Refer to Operator's Manual
8	Setup key: activates sub-screens for monitoring functions. Refer to Operator's Manual
9	Home key: returns display to main screen shown before standby
10	Rotary control: moves the cursor on the screen; confirms selection when pressed
11	Alarm Status indicators: Flashing Red: Warning; Flashing Yellow: Caution; Solid Yellow: Advisory
12	Alarm Silence key: silences all active alarms for two minutes
13	Power ON indicator: lighted when machine is plugged into an active AC outlet
14	Returns unit to Standby mode

13 FiO2 Measurement

The O2 sensor measures the fraction of inspired O2 (FiO2) in the respiratory gas.

The O2 sensor contains an alkaline electrolyte, a lead anode, two gold cathodes, and a Teflon membrane. The spatial separation of the two gold cathodes allows a voltage comparison to be made as explained below.

The O2 sensor is an electrochemical cell that generates a voltage from the ion current.

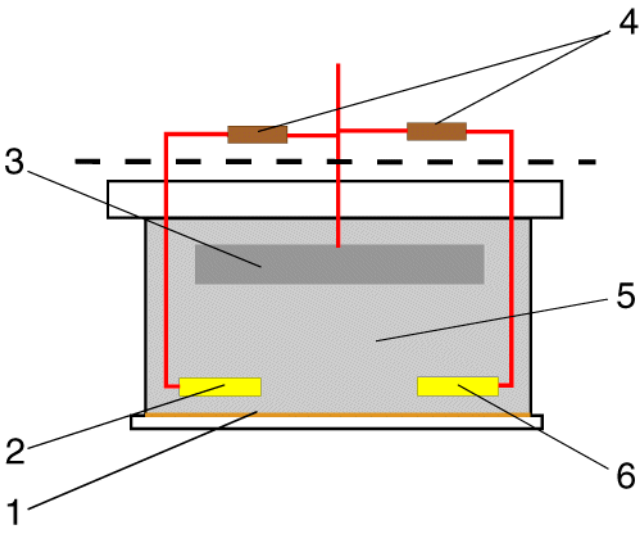

Figure 36 O2 sensor, for legend see Table 15

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Table 15 Legend to Figure 36

No.	Name
1	Teflon membrane
2	Gold cathode A
3	Lead anode
4	Temperature compensating resistors
5	Alkali electrolyte
6	Gold cathode B

The O2 to be measured diffuses through the Teflon membrane, reacts at the gold cathodes (negative polarity) and forms lead oxide and water at the lead anode (positive polarity). During this chemical process, a voltage is generated which is proportional to the O2 partial pressure.

The internal resistance of the cell is determined by the surface area of the gold cathodes, the O2 diffusion velocity, the distance between the gold cathodes and the lead anode. This resistance is approximately 700 ohms.

The chemical process is temperature-sensitive. Therefore temperature-sensitive resistors are connected in parallel with the O2 sensor. These resistors and the internal resistance of the O2 sensor correct the measuring voltage. Because two cathodes used in the O2 sensor cell, two different voltages are generated. These voltages are compared with each other. If their difference exceeds a certain value, the machine prompts the operator to check the cell.

If the O2 sensor fails, the control box will indicate an error on the graphics display.

14 Respiratory Flow Measurement

The flow sensor functions according to the constant temperature hot-wire anemometer principle. Respiratory gas flows past a thin platinum wire. This platinum wire (A) is located in a measuring tube and is electrically heated. The platinum wire is held at a constant temperature. Gas flow removes heat from the hot wire. The higher the gas flow rate, the greater the heat removal. The amount of electrical current needed to maintain a constant platinum wire temperature is thus proportional to the gas flow rate.

A second platinum wire (B) in the measuring tube is used to compensate for interferences from different gases present in the respiratory gas. The heat removed from the second platinum wire is measured during inspiration when the gas flow is zero.

The different gases present in the respiratory gas have a different thermal conductivity. The amount of heat removed from the second platinum wire is thus an indicator of respiratory gas composition.

Internal calibration tables for O2/N2O mixtures, Air and 100% O2 are used to linearize the measured flow.

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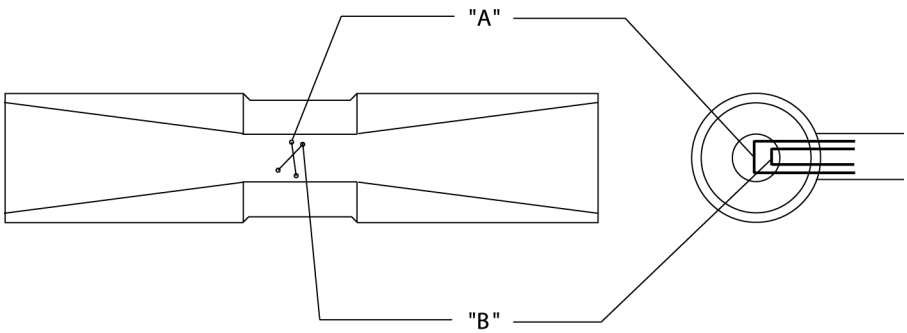

Figure 37 Respiratory Flow Sensor, for legend see Table 16

Table 16 Legend to Figure 37

No.	Name
“A”	Platinum wire “A”
“B”	Platinum wire “B”

15 Gas Flow Rate Measurement

The gas flow sensors operate on the principle of specific heat for individual gases. In each sensor, as the gas flows through a heated chamber the gas molecules carry away a certain amount of heat relative to the specific heat index for that gas.

A known amount of electrical current is required to maintain the temperature in the heated chamber. The higher the gas flow rate, the more heat is removed from the chamber and more current is required to maintain the temperature in the chamber. This current is then scaled and displayed as liters per minute flow rate for each gas.

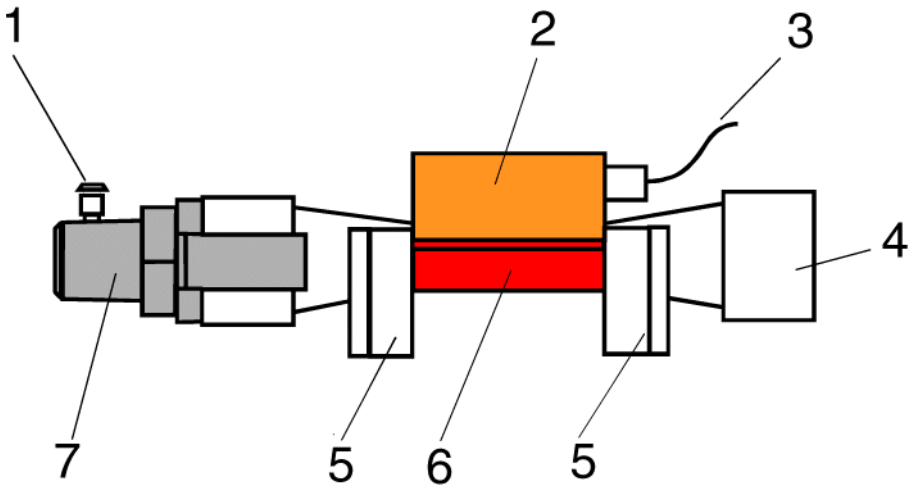

Figure 38 Flow Sensor Details, for legend see Table 17

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Table 17 Legend to Figure 38

No.	Name
1	Tubing connector
2	Electronic components
3	Electrical connection
4	Gas outlet port (to manifold)
5	Mounting posts
6	Heated chamber
7	Gas inlet assembly

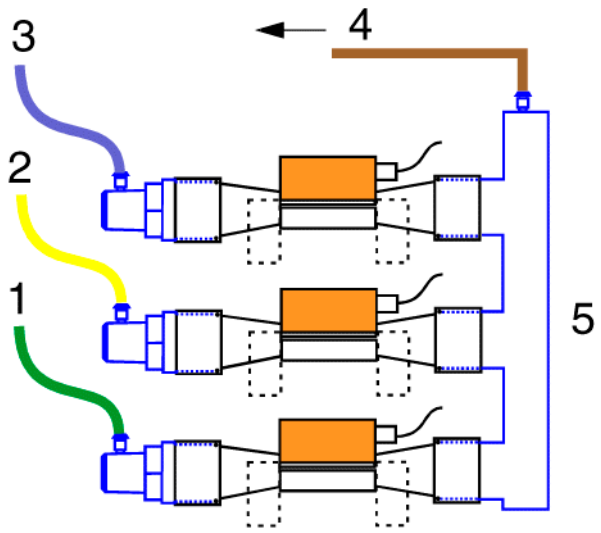

Figure 39 Flow of Gases Through Sensors, for legend see Table 18

Table 18 Legend to Figure 39

No.	Name
1	from Oxygen flow control valve
2	from Air flow control valve
3	from Nitrous flow control valve
4	Fresh gas flow to Total fresh gas flowmeter
5	Fresh gas manifold

16 Vaporizer

Refer to separate technical documentation of the anesthetic vaporizer.

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1 Leak test

The leak test menu screen instructs the user how to begin the leak test.

After preparing the machine, the user initiates the test.

If the size of the leak is outside the tolerance range, an appropriate message is displayed to tell the user that the system leak test has failed.

1.1 System leak test

1. The leak test menu prompts the user to plug the Y-piece and to flip the Man/Spont valve to “Man” (with the pressure set to 40 to 50 mbar).
2. The motor control then moves the piston upward. Then the user activates the O2 flush to increase the system pressure to a value between 15 and 30 mbar.
3. The software monitors the airway pressure.
4. If the airway pressure is in range, the airway pressure is then allowed to drop for 15 seconds or by 1.5 mbar. If no appreciable pressure drop occurred in 15 seconds, the leak test is considered “passed”.
5. If the pressure has decreased significantly (up to 1.5 mbar), the piston will move upward until the airway pressure has increased 2 mbar, or the piston has moved upward a specific volume of 160 mL, whichever comes first.
6. The upward piston movement in mL, divided by the increase in airway pressure yields the system compliance value. This compliance value is used when calculating the system leak rate only. The system compliance is calculated in the next step upon completion of the system leak test.
7. The total time that elapsed between the start of the piston movement and the transition pressure drop by 1.5 mbar is the time base for the leak calculation.

1.2 Patient leak test

The patient leak test is done in a similar way to the system leak test:

1. The PEEP/Pmax valve is used to close off the expiratory part of the pneumatic circuit. Only the patient circuit is tested.
2. The test begins by opening the PEEP valve and checking where the current piston position is.
3. If the piston is above the desired starting position the piston is servoed downward.
4. If the piston is below the desired starting position the piston is servoed upward.
5. Then the PEEP valve is closed and the piston is moved upward.
6. When the airway pressure has reached 30 mbar, the piston is paused at that position and maintained there by the servo function.
7. Once the pressure has stabilized, the state changes to “waiting for leak.”
8. When the airway pressure and ventilator pressure have dropped 1 mbar or the elapsed waiting time exceeds 20 seconds, the state changes to calculation of the leak in mL and leak rate in mL/min.
9. The software detects that the completion state has gone to “pass” or “fail” and will then display the leak test results on the leak test screen (or display an appropriate error message, if the completion state is one of the error conditions).

The result of the “patient leak test” is displayed after each test.

F5330500_Leaktest.fm 03.11.04
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The result of the “system leak test” is displayed only if the value is outside the tolerance range.
Otherwise only OK will be displayed.

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F5330500_Leaktest.fm 03.11.04

Annex

Spare parts list

Technical Information according to EMC standard IEC/EN 60601-1-2:2001

Dräger medical
A Dräger and Siemens Company

Spare parts catalogue

Fabius GS

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	6850645	CAPSULE FOR O2-DETECTOR (DW)	1.000	St	00000000		
	8403735	Set of 5 Spirolog sensors	1.000	St	29991231		
	8604874	TUBE PEEP / APL COSY RIGHT	1.000	St	29991231		
	8604875	TUBE PEEP / APL COSY LEFT	1.000	St	29991231		
	1190520	HOSE 4X1,5-SI 50 SH A NF	1.000	m	29991231		

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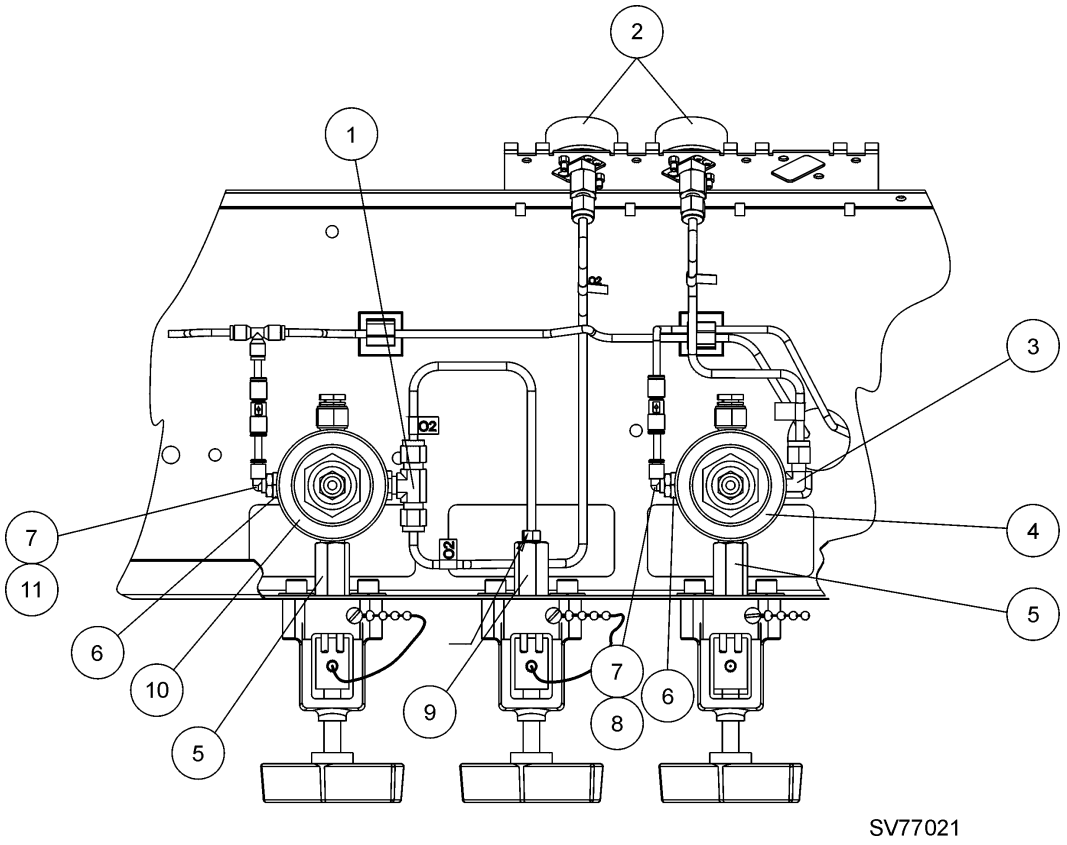

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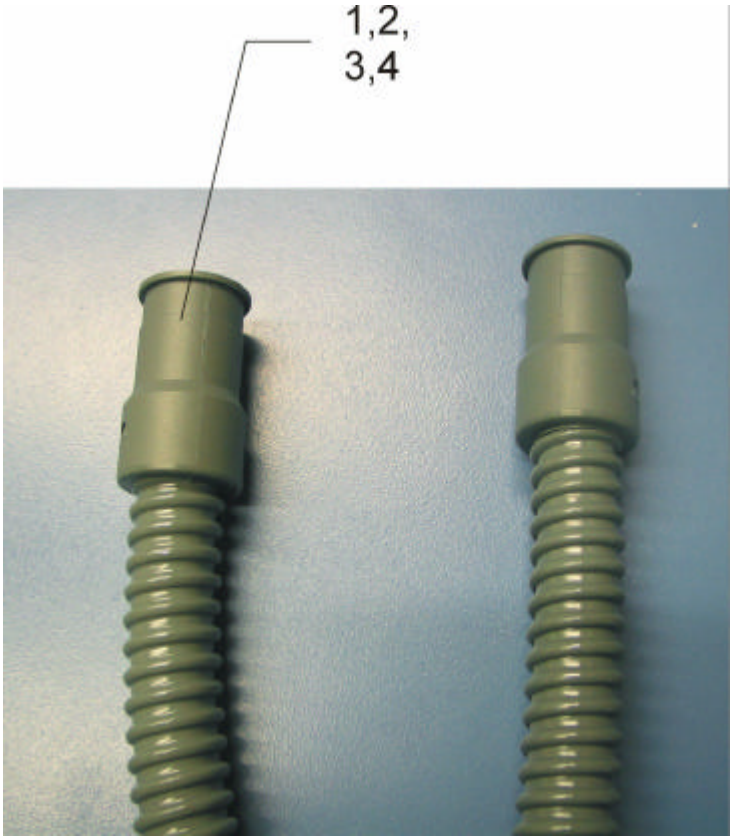

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3	M33298	AGS-SCAVANGER HOSE 3M	1.000	St	00000000		
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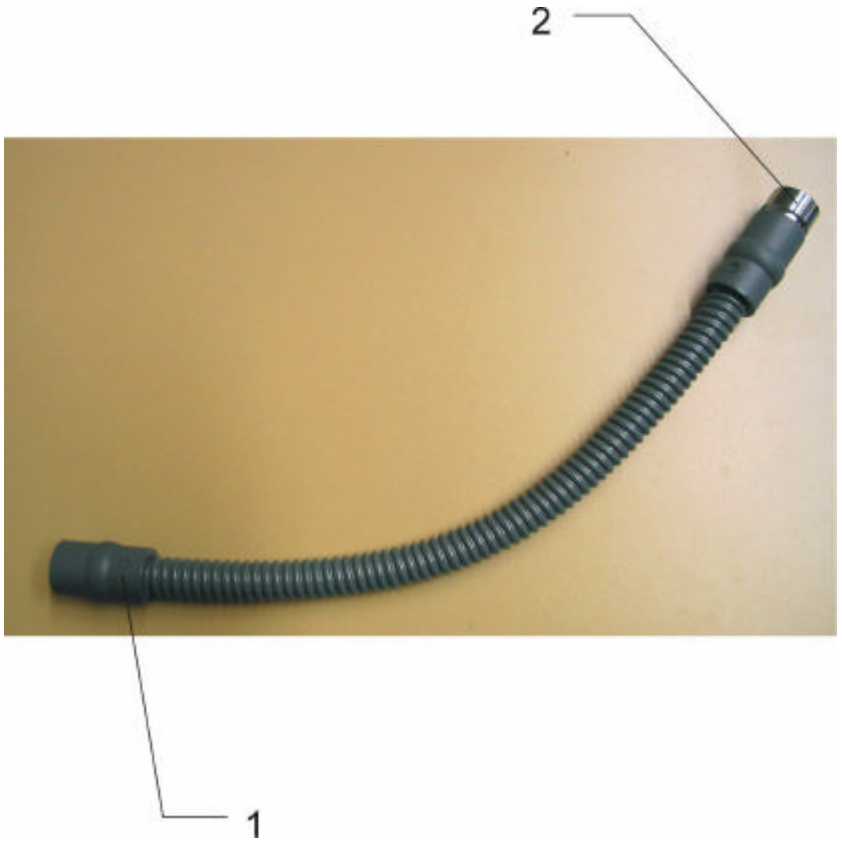

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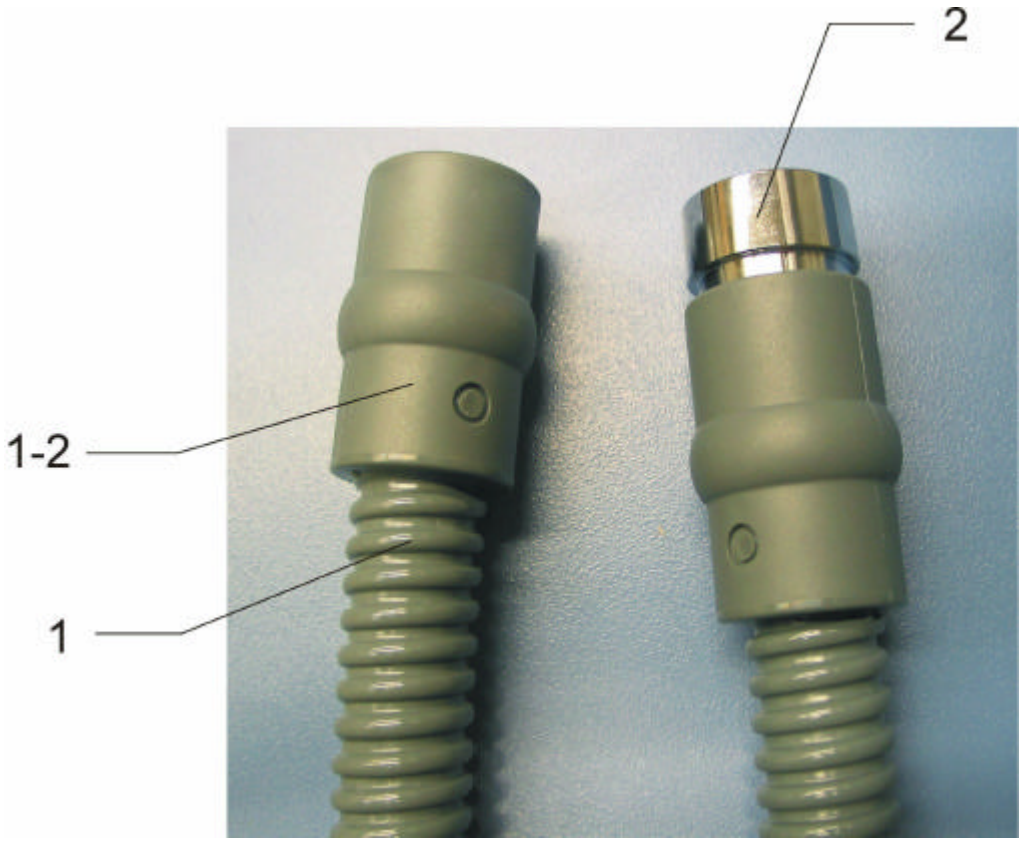

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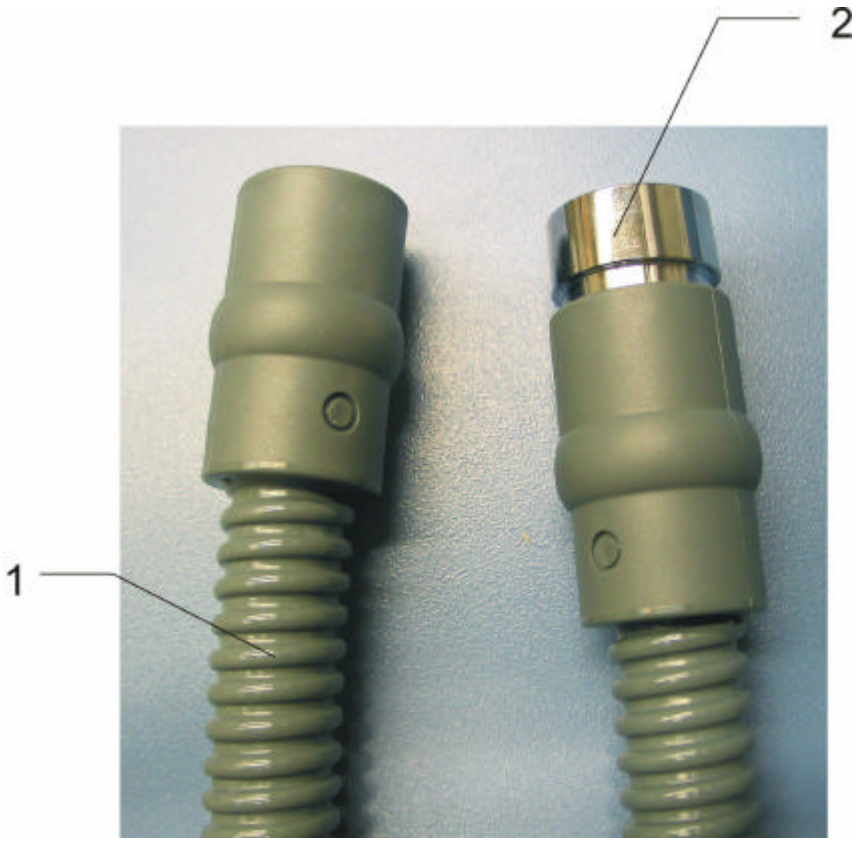

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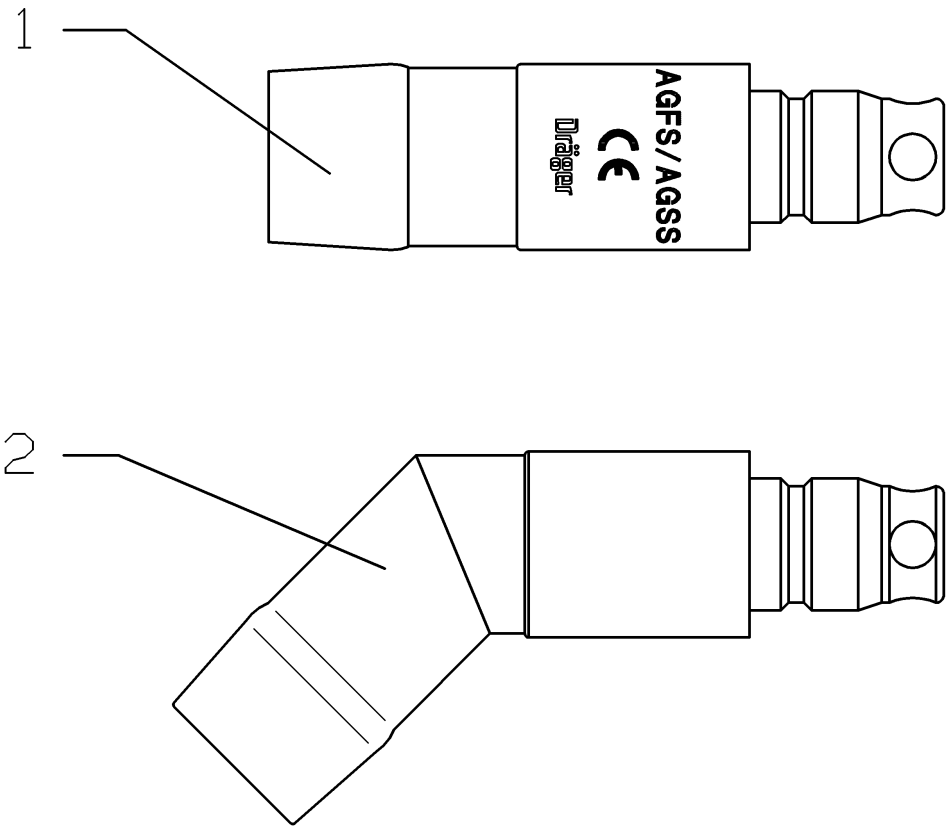

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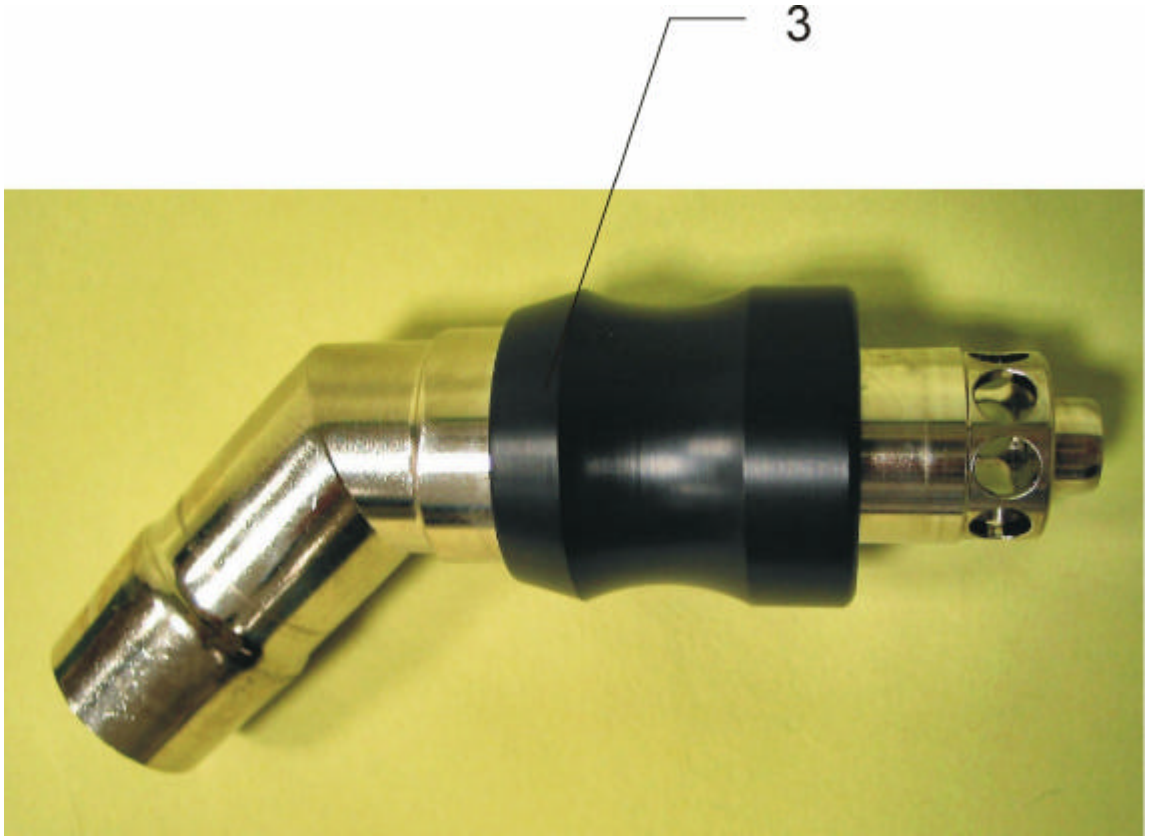

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	9029426	INSTRUCTIONS FOR USE AGS FR/ES	1.000	St	29991231		
	9029425	INSTRUCTIONS FOR USE AGS DA/IT	1.000	St	29991231		
	9037424	INSTRUCTIONS FOR USE AGS FR/NL	1.000	St	29991231		

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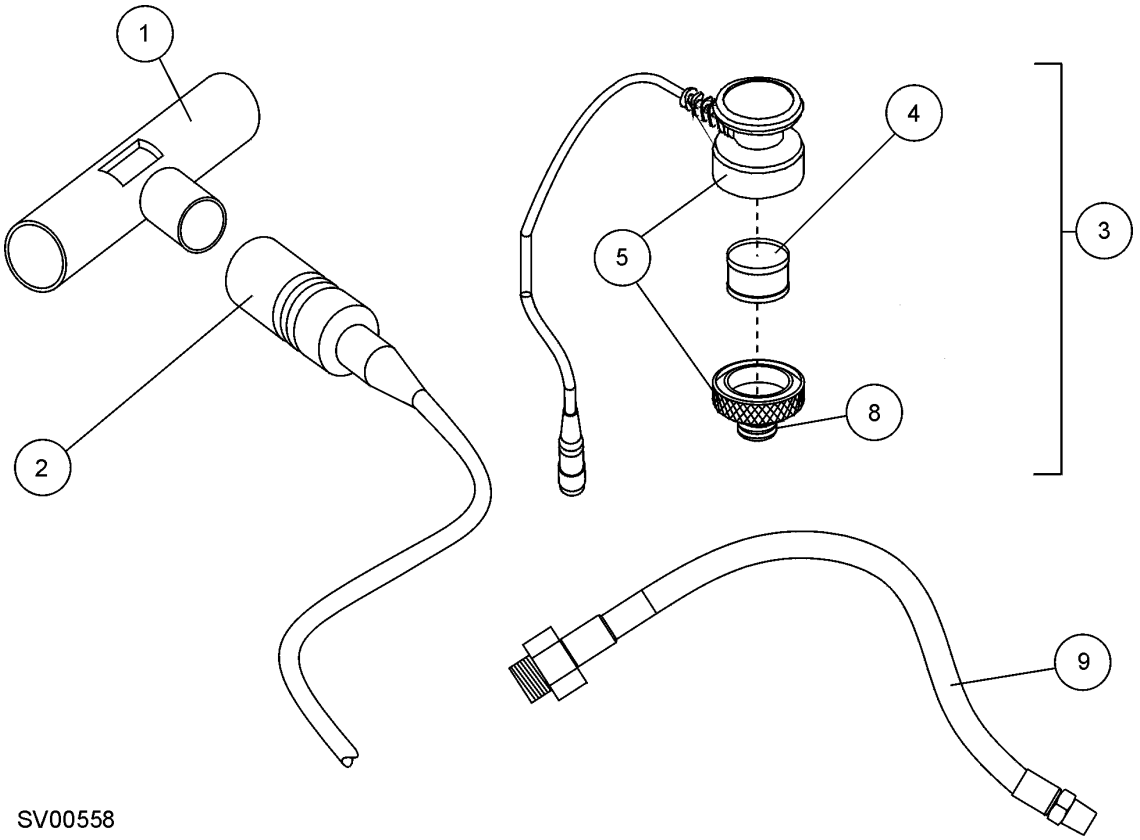

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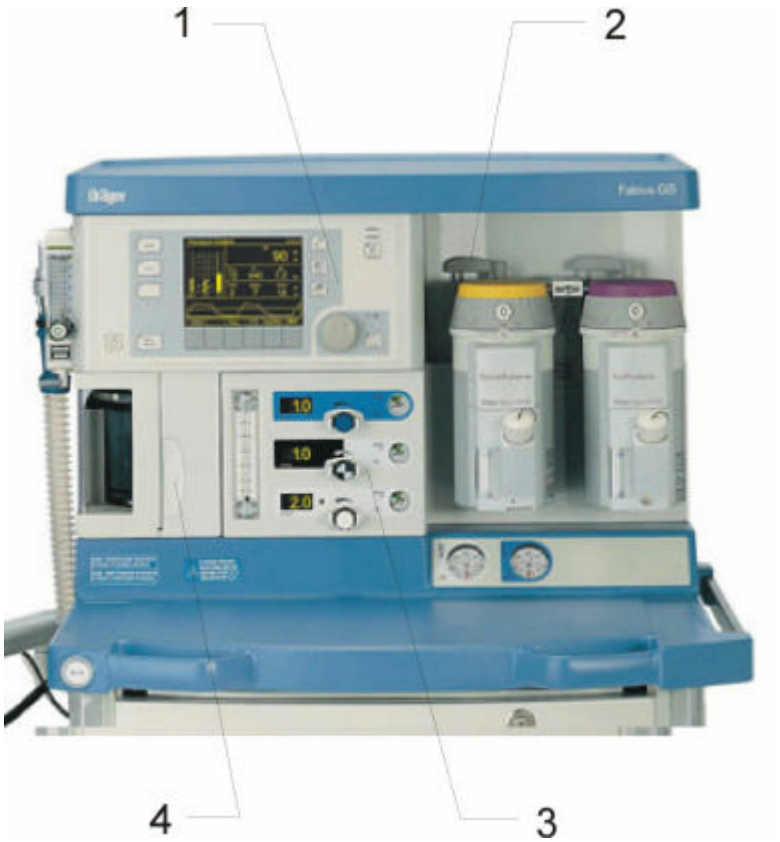

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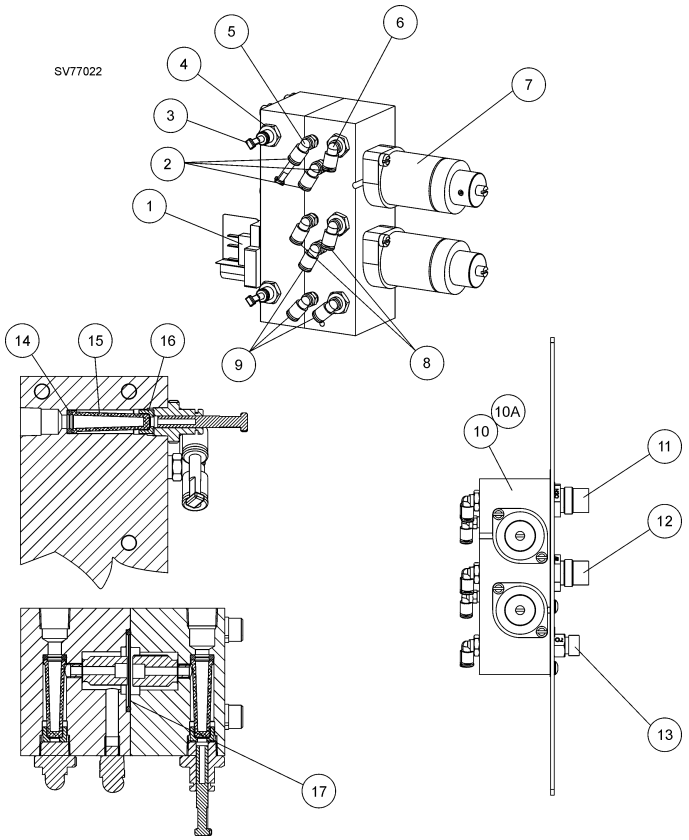

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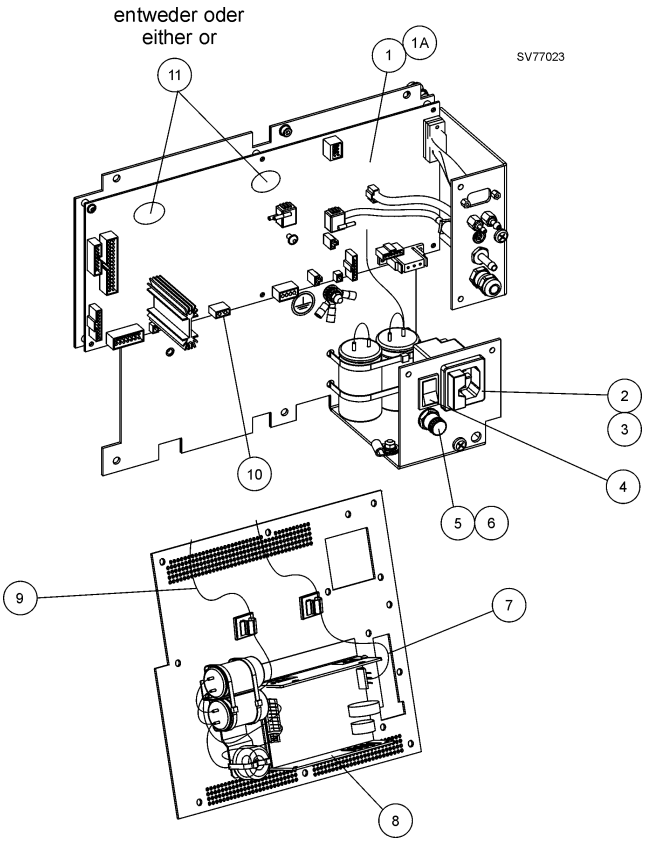

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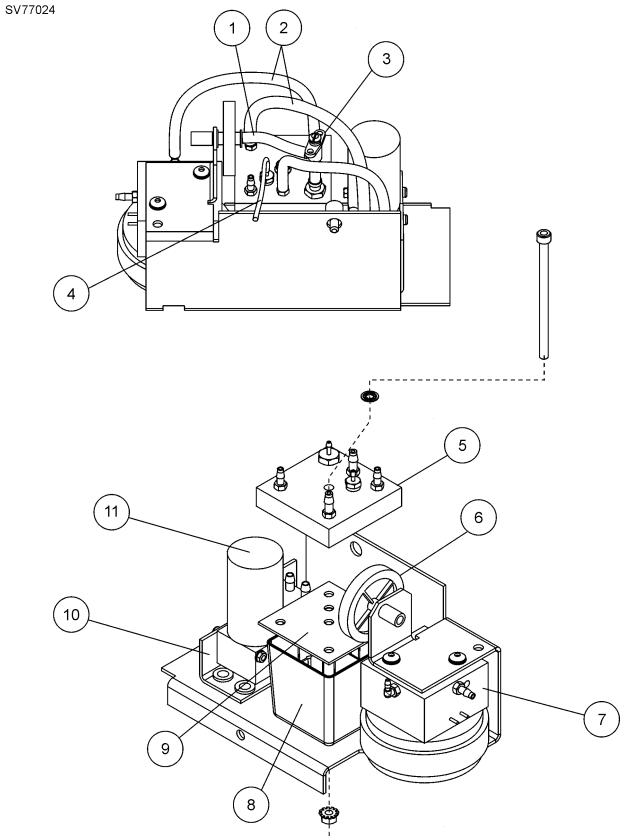

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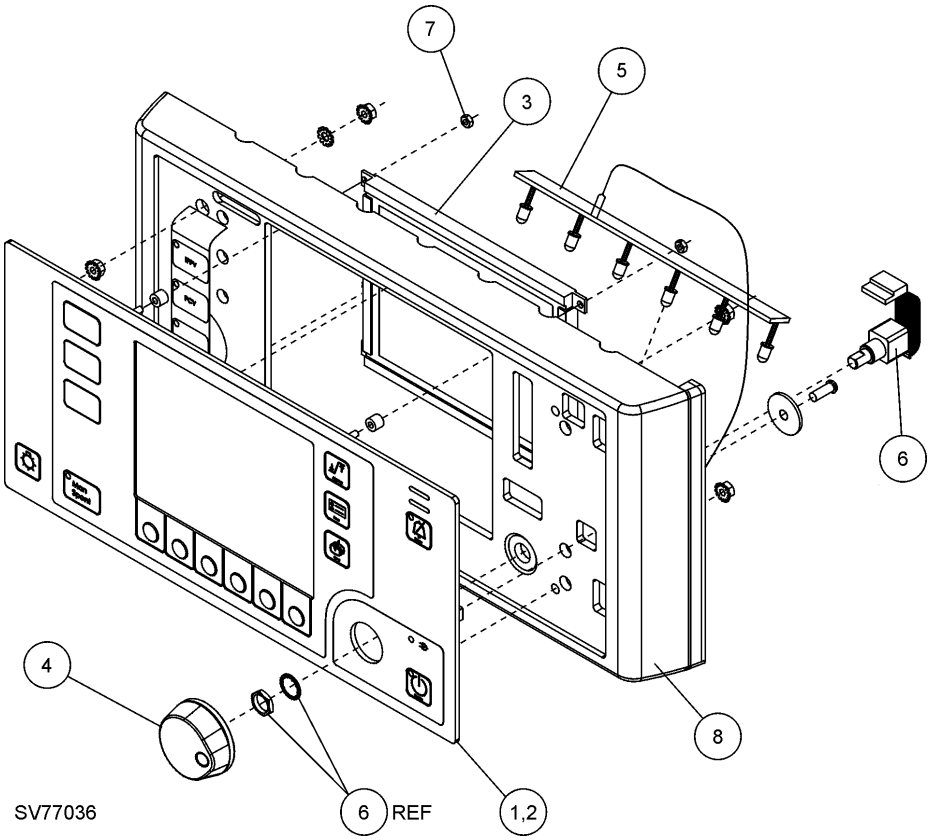

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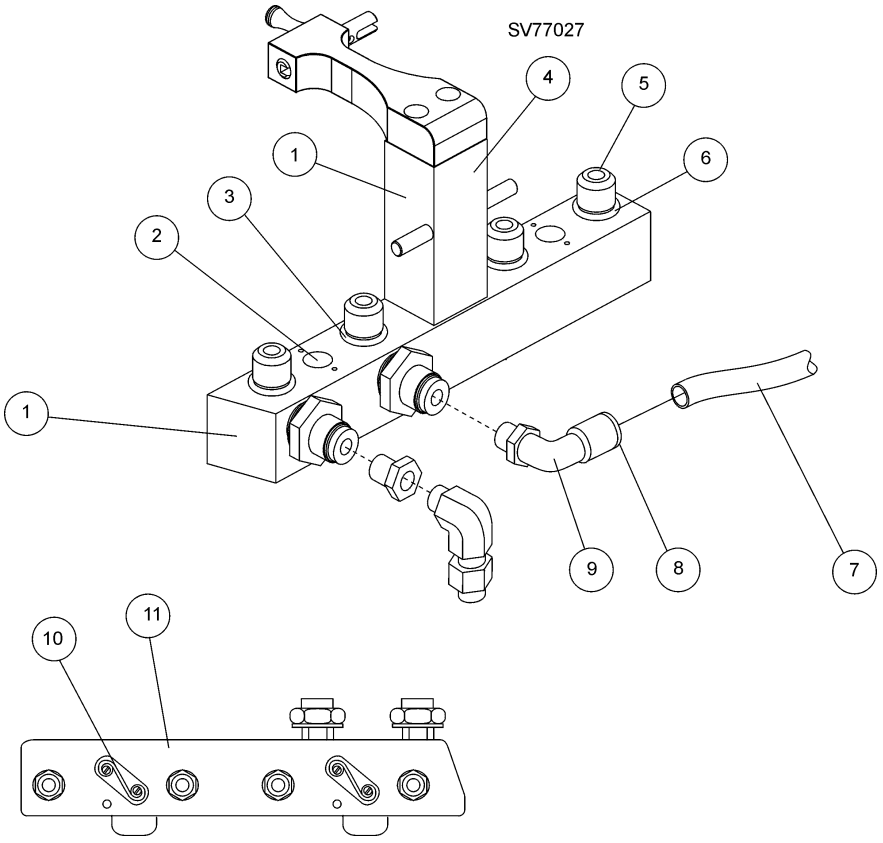

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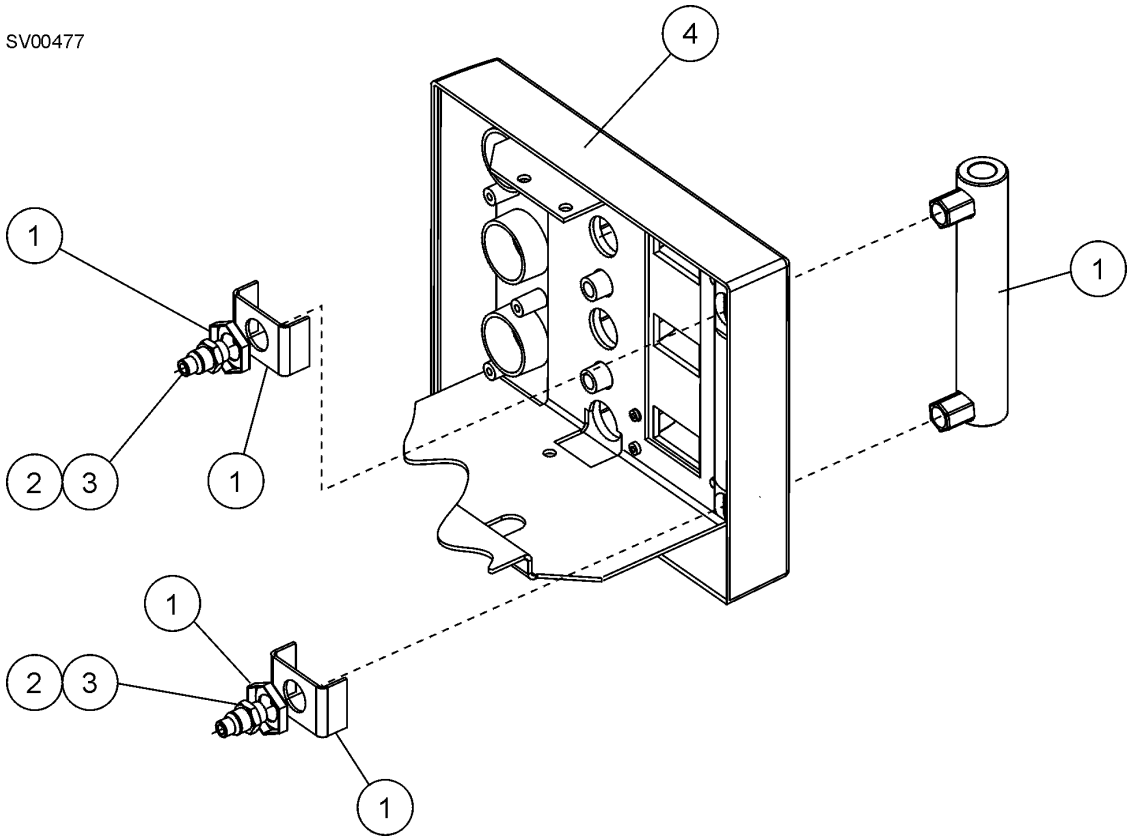

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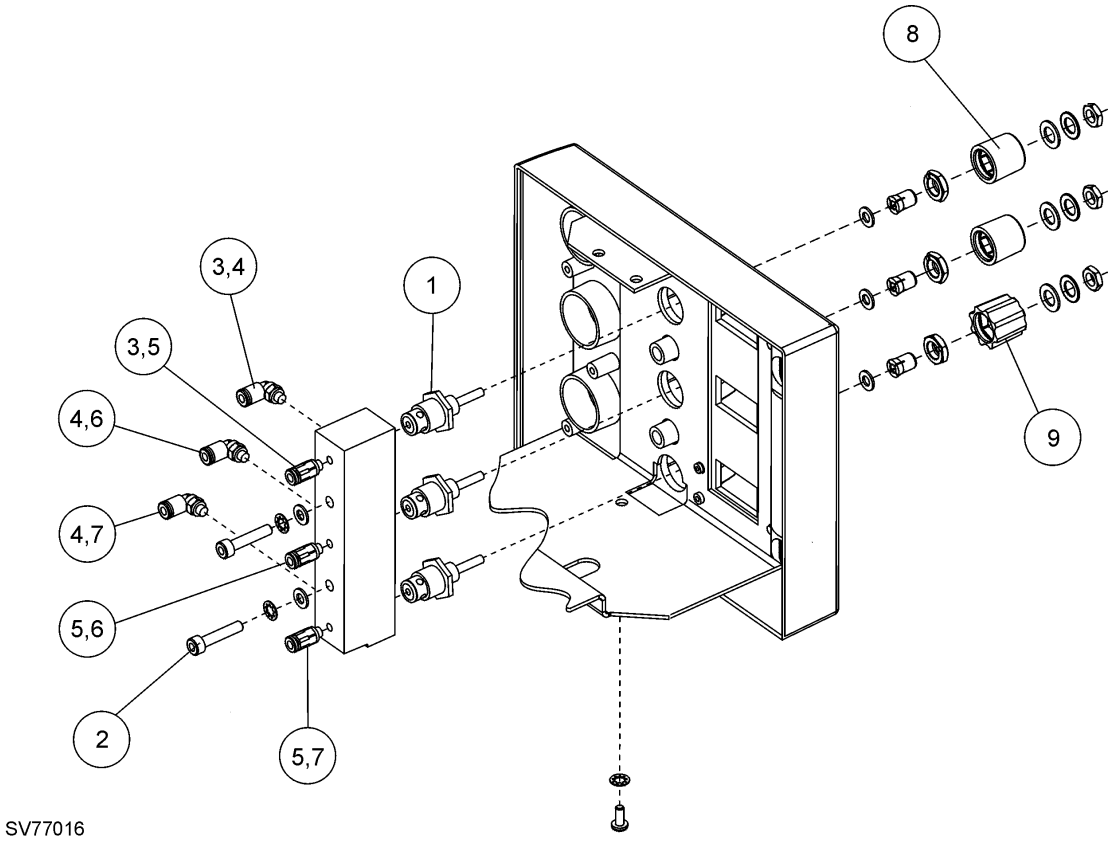

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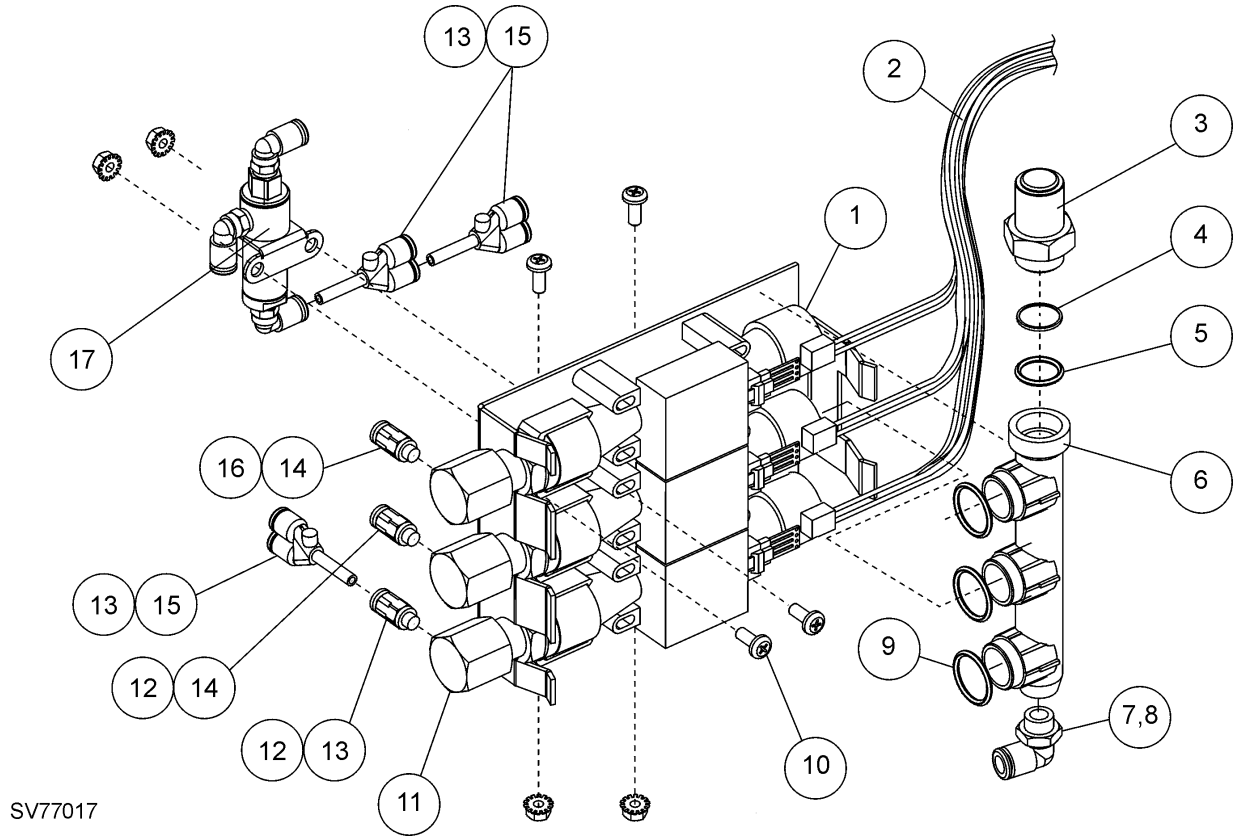

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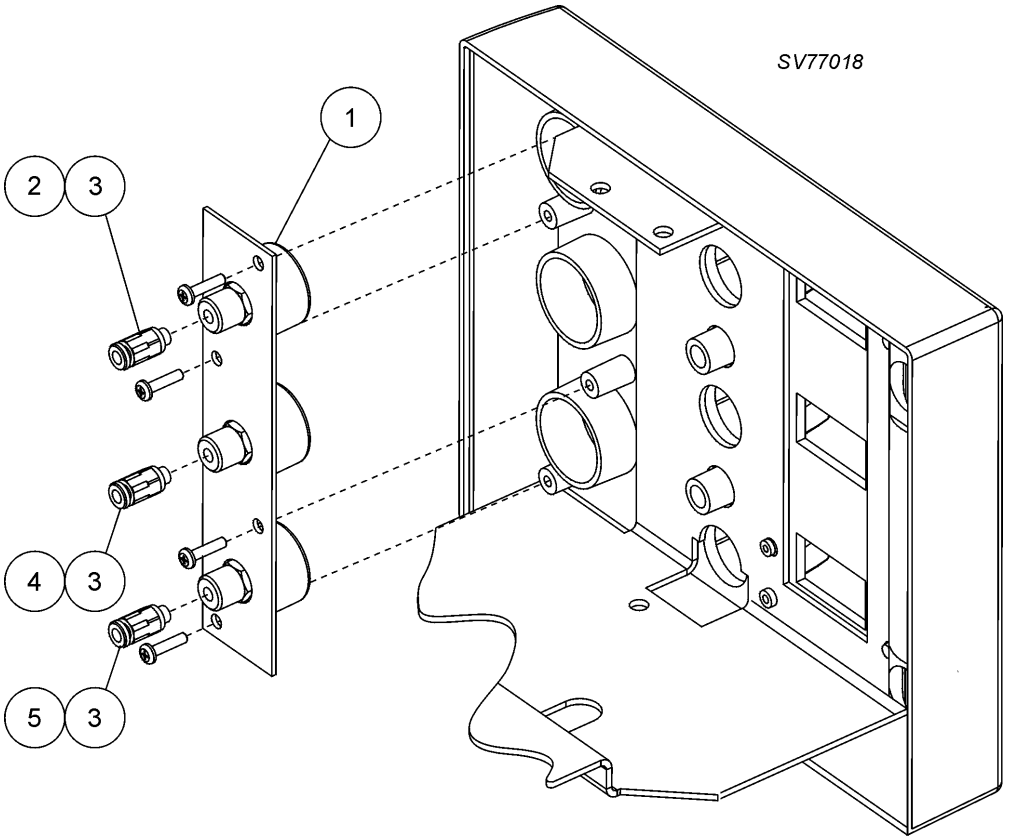

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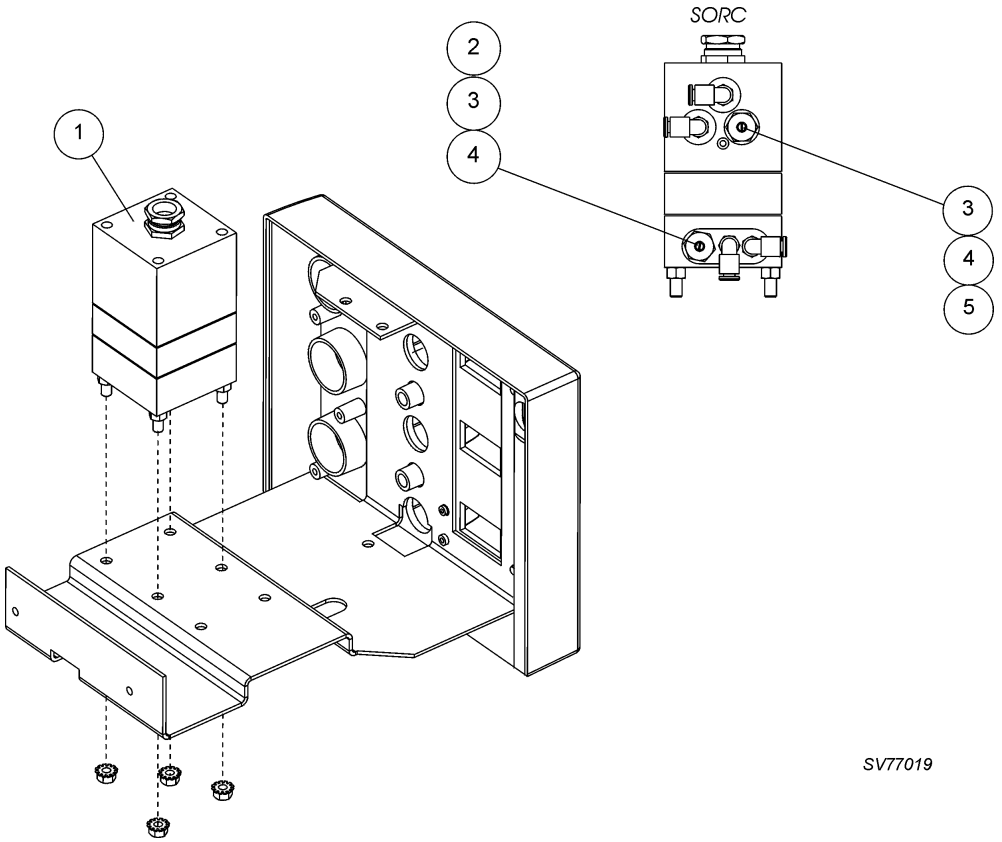

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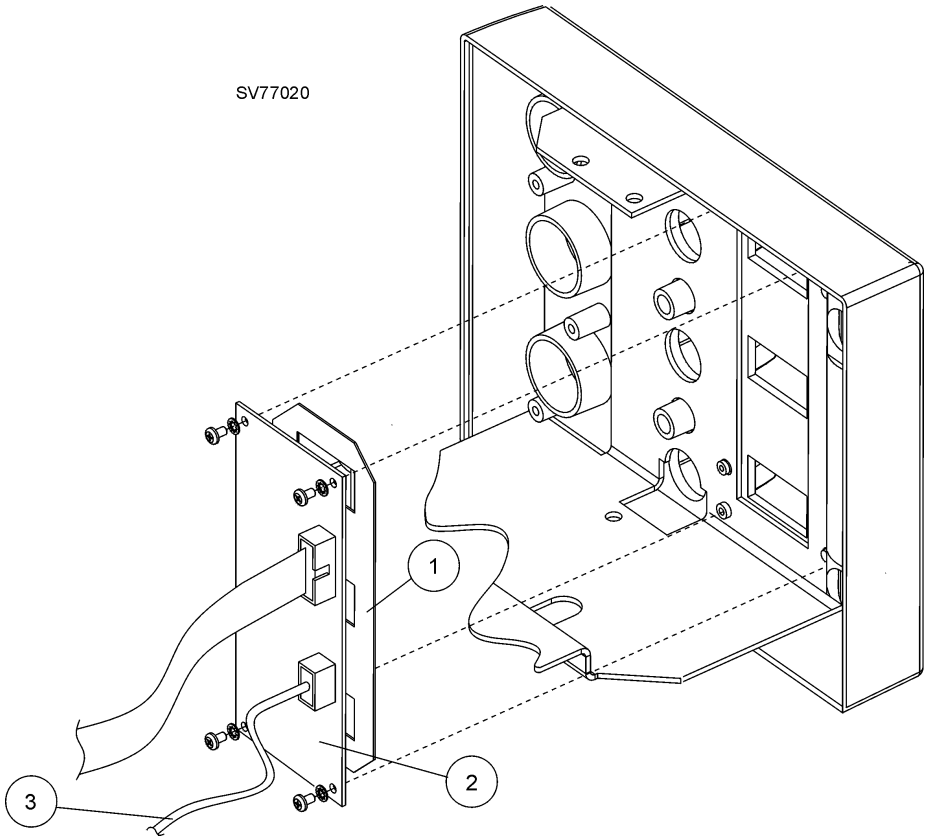

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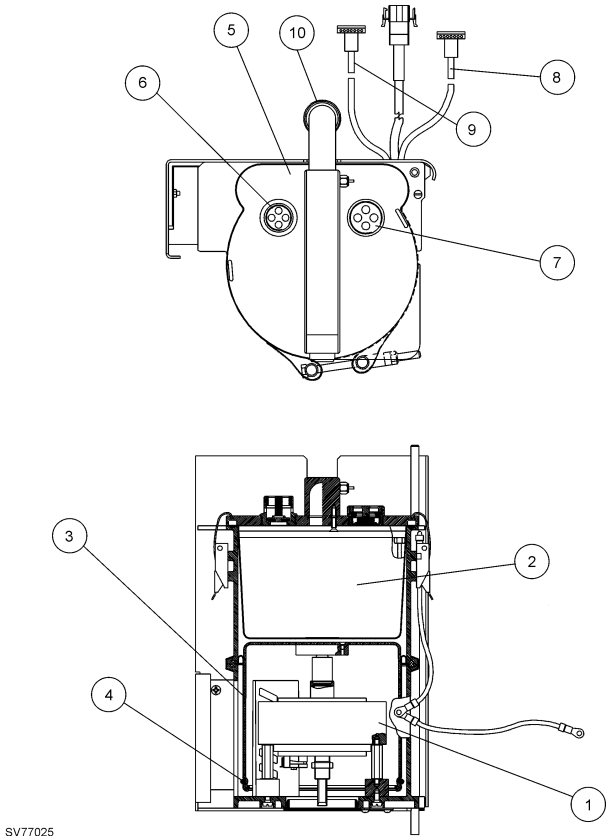

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5	8604319	patient assembly	1.000	St	29991231		
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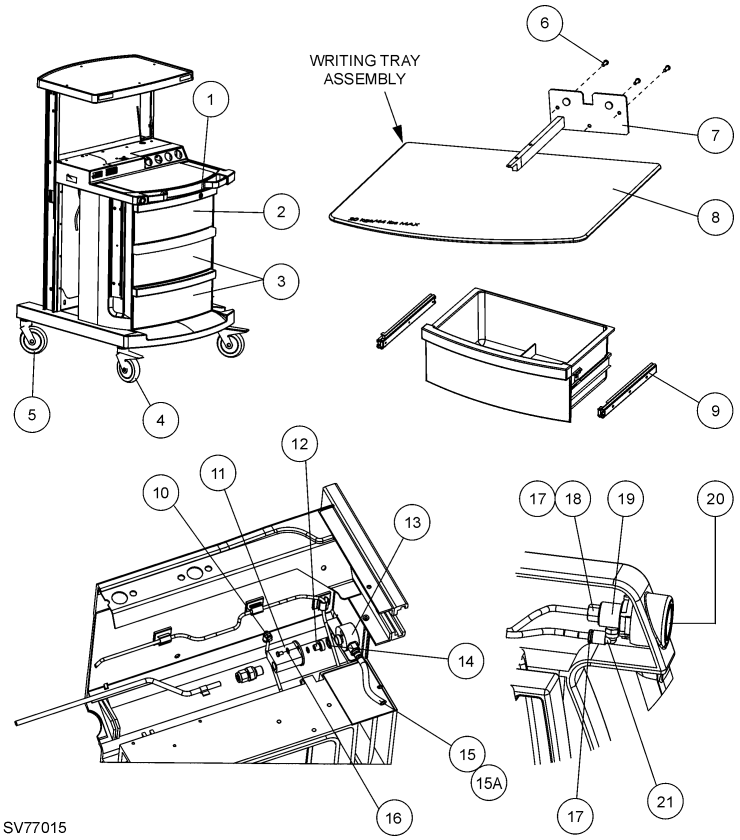

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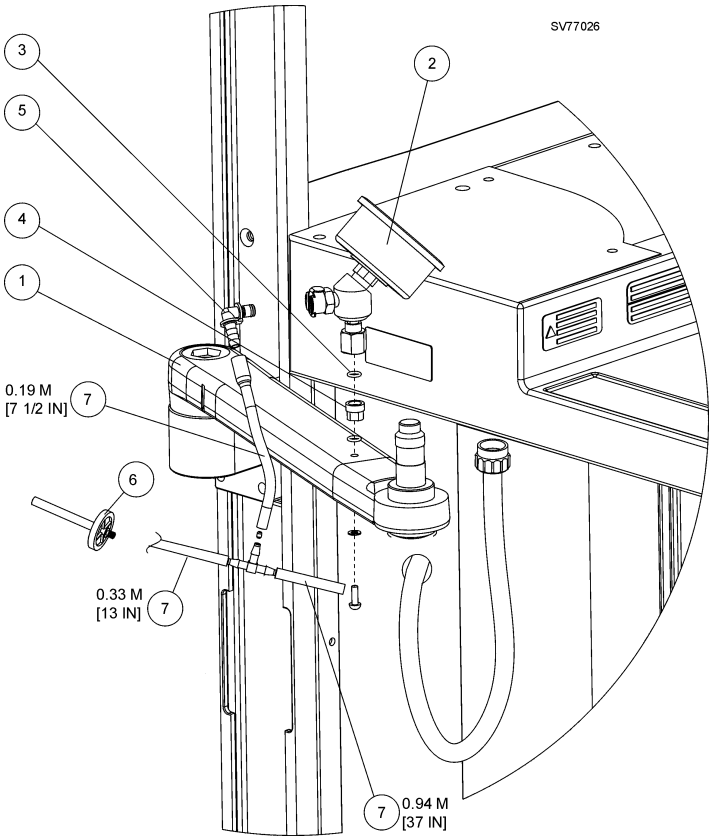

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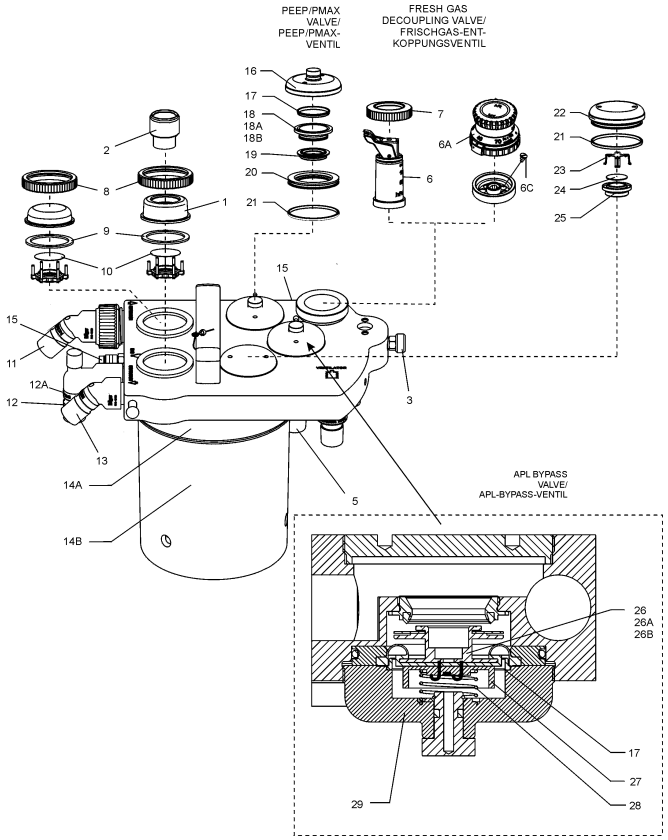

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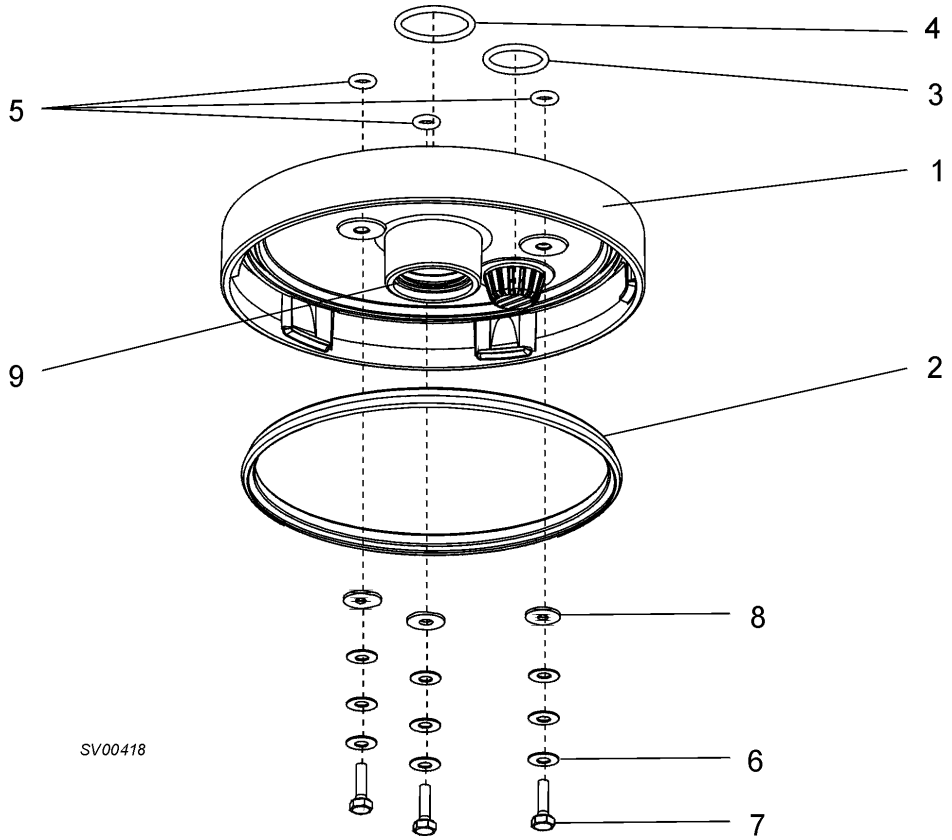

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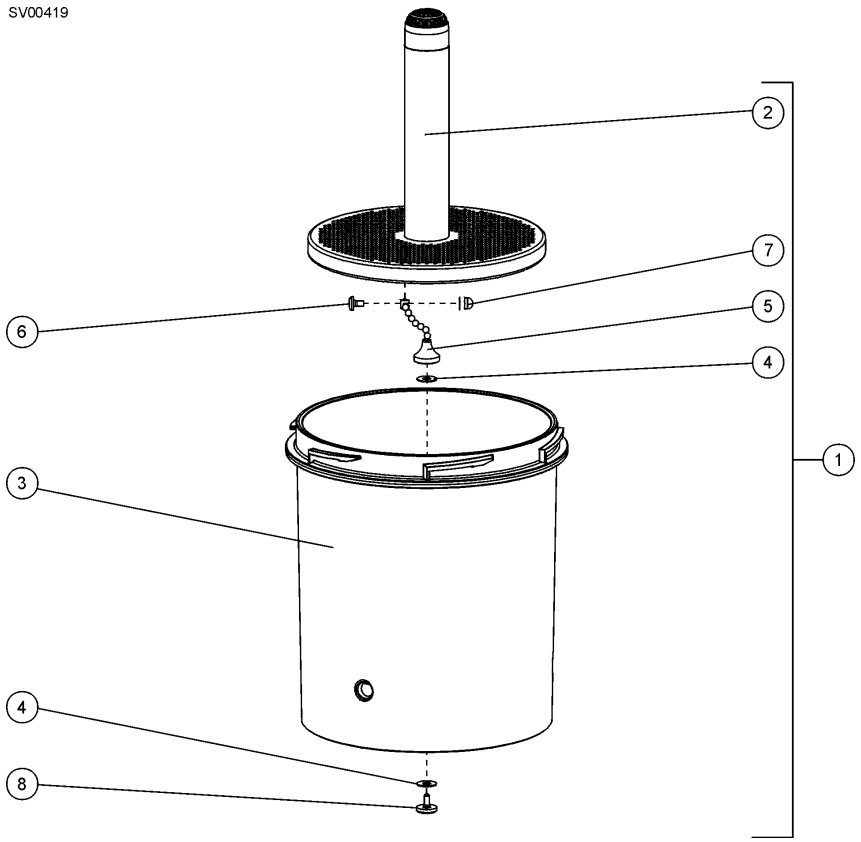

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1	M29320	ABSORBER CICERO	1.000	St	29991231		
2	M29999	ABSORBER INSERT	1.000	St	29991231		
3	M29994	ABSORBER POT	1.000	St	29991231		

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Item No.	Part No.	Description	Qty.	Qty.unit	Rep.end	Page	Remark

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Item No.	Part No.	Description	Qty.	Qty.unit	Rep.end	Page	Remark
	9037780	GA Fabius GS de	1.000	St	20101231		
	9037796	GA Fabius GS enUS	1.000	St	20101231		
	9037781	GA Fabius GS en	1.000	St	20101231		
	9037782	GA Fabius GS fr	1.000	St	20101231		
	9037783	GA Fabius GS ja	1.000	St	20101231		
	9037784	GA Fabius GS es	1.000	St	20101231		
	9037785	GA Fabius GS it	1.000	St	20101231		
	9037786	GA Fabius GS no	1.000	St	20101231		
	9037787	GA Fabius GS ru	1.000	St	20101231		
	9037788	GA Fabius GS pt	1.000	St	20101231		
	9037789	GA Fabius GS zh	1.000	St	20101231		
	9037791	GA Fabius GS nl	1.000	St	20101231		
	9037792	GA Fabius GS pl	1.000	St	20101231		
	9037793	GA Fabius GS sv	1.000	St	20101231		

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Item No.	Part No.	Description	Qty.	Qty.unit	Rep.end	Page	Remark
	9037794	GA Fabius GS cs	1.000	St	20101231		
	9037795	GA Fabius GS ro	1.000	St	20101231		
	9037932	IfU Fabius GS 2.n de	1.000	St	00000000		
	9037933	IfU Fabius GS 2.n en gb	1.000	St	00000000		
	9037934	IfU Fabius GS 2.n fr	1.000	St	00000000		
	9037935	IfU Fabius GS 2.n ja	1.000	St	00000000		
	9037936	IfU Fabius GS 2.n es	1.000	St	00000000		
	9037937	IfU Fabius GS 2.n it	1.000	St	00000000		
	9037938	IfU Fabius GS 2.n no	1.000	St	00000000		
	9037939	IfU Fabius GS 2.n ru	1.000	St	00000000		
	9037940	IfU Fabius GS 2.n pt	1.000	St	00000000		
	9037941	IfU Fabius GS 2.n zh	1.000	St	00000000		
	9037942	IfU Fabius GS 2.n hu	1.000	St	00000000		
	9037943	IfU Fabius GS 2.n nl	1.000	St	00000000		

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Ningún plano previsto

Item No.	Part No.	Description	Qty.	Qty.unit	Rep.end	Page	Remark
	9037944	IfU Fabius GS 2.n pl	1.000	St	00000000		
	9037945	IfU Fabius GS 2.n sv	1.000	St	00000000		
	9037946	IfU Fabius GS 2.n cs	1.000	St	00000000		
	9037947	IfU Fabius GS 2.n ro	1.000	St	00000000		
	9037948	IfU Fabius GS 2.n en us	1.000	St	00000000		

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Description	Part No.	Page

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2004-10-28

Technical Documentation for Fabius GS / Fabius Tiro according to EMC standard IEC/EN 60601-1-2: 2001

General Information

The EMC conformity includes the use of following external cables, transducers and accessories:

Designation	Order no.
Data cable 1 m Sub-D9 f/m 1:1	8601565
Data cable 2 m Sub-D9 f/m 1:1	8601474
Data cable 3 m Sub-D9 f/m 1:1	8601528

Additionally, accessories may be used which do not affect EMC compliance, if no other reasons (see accessories list) interdict the use of them. The non-compliance may result in increased emissions or decreased immunity of the Fabius GS / Fabius Tiro.

The Fabius GS / Fabius Tiro should not be used adjacent to or stacked with other equipment. If adjacent or stacked use is inevitable, the Fabius GS / Fabius Tiro should be observed to verify normal use in the configuration in which it will be used.
Other equipment which can be used adjacent to or stacked with the Fabius GS / Fabius Tiro are listed in the Instructions for Use manual, in the Accessories List / Family Drawing.

Electromagnetic Emissions

Electromagnetic Emissions		
The Fabius GS / Fabius Tiro is intended for use in the electromagnetic environment specified below. The user should assure that is used in such an environment.		
Emissions	**Compliance according to**	**Electromagnetic environment**
RF emissions (CISPR 11)	Group 1	The Fabius GS / Fabius Tiro uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.
	Class B	The Fabius GS / Fabius Tiro is suitable for use in all establishments including domestic establishments and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic emissions (IEC 61000-3-2)	Class A	N/A
Voltage fluctuations / flicker (IEC 61000-3-3)	Complies	N/A

Information re electromagnetic emissions (IEC 60101-1-2: 2001, table 201)

Electromagnetic Immunity

Electromagnetic Immunity			
The Fabius GS / Fabius Tiro is intended for use in the electromagnetic environment specified below. The user should assure that is used in such an environment.			
Immunity against	**IEC 60601-1-2 test level**	**Compliance level (of this equipment)**	**Electromagnetic environment**
electrostatic discharge, ESD (IEC 61000-4-2)	contact discharge: ± 6 kV air discharge: ± 8 kV	± 6 kV ± 8 kV	Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
electrical fast transients / bursts (IEC 61000-4-4)	power supply lines: ± 2 kV longer input / output lines: ± 1 kV	± 2 kV ± 1 kV	Mains power quality should be that of a typical commercial or hospital environment.
surges on AC mains lines (IEC 61000-4-5)	common mode: ± 2 kV differential mode: ± 1 kV	± 2 kV ± 1 kV	Mains power quality should be that of a typical commercial or hospital environment.
power frequency magnetic field 50/60 Hz (IEC 61000-4-8)	3 A/m	3 A/m	In close vicinity to the Fabius GS / Fabius Tiro, no equipment with extraordinary power frequency magnetic fields (power transformers, etc.) should be operated.
voltage dips and short interruptions on AC mains input lines (IEC 61000-4-11)	dip >95%, 0.5 periods dip 60%, 5 periods dip 30%, 25 periods dip >95%, 5 seconds	>95%, 0.5 per. 60%, 5 per. 30%, 25 per. >95%, 5 sec.	Mains power quality should be that of a typical commercial or hospital environment. If user requires continued operation during power mains interruptions, it is recommended to power the Fabius GS / Fabius Tiro from an uninterruptible supply or a battery.
radiated RF (IEC 61000-4-3)	80 MHz – 2.5 GHz: 10 (3) V/m	10 V/m	Recommended separation distance from portable and mobile RF transmitters with transmission power P_{EIRP} to the Fabius GS / Fabius Tiro including its lines: 1.84 m * $\sqrt{P_{EIRP}}$ [X1]
RF coupled into lines (IEC 61000-4-6)	150 kHz – 80 MHz: 10 (3) V within ISM bands, 3 V outside ISM bands [X2]	10 V 3 V	Recommended separation distance from portable and mobile RF transmitters with transmission power P_{EIRP} to the Fabius GS / Fabius Tiro including its lines: 1.84 m * $\sqrt{P_{EIRP}}$ [X1]

Information re electromagnetic immunity (IEC 60601-1-2: 2001, tables 202, 203, 204)

[X1]: For P_{EIRP} the highest possible "equivalent isotropic radiated power" of the adjacent RF transmitter has to be inserted (value in Watt). Also in the vicinity of equipment marked with the symbol interference may occur. Field strengths from fixed, portable or mobile RF transmitters at the location of the Fabius GS / Fabius Tiro should be less than 3 V/m in the frequency range from 150 kHz to 2.5 GHz and less than 1 V/m above 2.5 GHz.

[X2]: ISM bands in this frequency range are: 6.765 MHz - 6.795 MHz, 13.553 MHz - 13.567 MHz, 26.957 MHz - 27.283 MHz, 40.66 MHz - 40.70 MHz.

Recommended separation distances

Recommended separation distances between portable and mobile RF telecommunication devices and the Fabius GS / Fabius Tiro			
max. P_{EIRP} (W)	**3 V/m distance* (m)**	**1 V/m distance* (m)**	**Note**
0.001	0.06	0.17	
0.003	0.10	0.30	
0.010	0.18	0.55	
0.030	0.32	0.95	e.g. WLAN 5250 / 5775 (Europe)
0.100	0.58	1.73	e.g. WLAN 2440 (Europe), Bluetooth
0.200	0.82	2.46	e.g. WLAN 5250 (not in Europe)
0.250	0.91	2.75	e.g. DECT devices
1.000	1.83	5.48	e.g. GSM 1800- / GSM 1900- / UMTS- mobiles, WLAN 5600 (not in Europe)
2.000	2.60	7.78	e.g. GSM 900 mobiles
3.000	3.16	9.49	

Information re separation distances (IEC 60601-1-2: 2001, tables 205 and 206)

* 3 V/m distance to transmitters with frequencies from 150 kHz to 2.5 GHz, otherwise 1 V/m distance.

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